

# SPECIFICATIONS

## PROJECT NO. DGS C-0969-0017 PHASE 1

Contract No. DGS C-0968-0017 Phase 1.1 – General Construction  
Contract No. DGS C-0968-0017 Phase 1.2 – HVAC Construction  
Contract No. DGS C-0968-0017 Phase 1.3 – Plumbing Construction  
Contract No. DGS C-0969-0017 Phase 1.4 – Electrical Construction

For

**Construction of New Community Living Center, Hollidaysburg  
Veteran's Home  
Department of Military & Veterans' Affairs (BVH)  
Duncansville, Blair County, PA**

**COMMONWEALTH OF PENNSYLVANIA  
DEPARTMENT OF GENERAL SERVICES  
HARRISBURG, PENNSYLVANIA**

**Tom Wolf, Governor  
Joseph H. Lee, Acting Secretary**



**Date: October 7, 2022**

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**SECTION 01 01 00**  
**SUMMARY OF WORK**

**PART 1 – GENERAL**

1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 LOCATION

- A. Hollidaysburg Veteran's Home – Construction of New Community Living Center  
500 Municipal Drive, Duncansville, Pennsylvania 16635  
Blair County

1.3 PROJECT DESCRIPTION

- A. Construction of a new three-story, 175,000 GSF skilled nursing facility, Type IB Construction. Work includes but is not limited to the following: site work, grading, utility work, landscaping, concrete footings and foundation walls, masonry, pre-cast concrete, steel frame construction, exterior rain screen, single-ply roofing, metal framing, interior finishes, interior and exterior signage, elevators, HVAC, electrical, plumbing, low-voltage, and related work.

1.4 CONTRACT DURATION

- A. The Construction Contract duration shall be 730 calendar days commencing on the date of the Initial Job Conference.

1.5 WORK INCLUDED

- A. The Work of this Project consists of, but is not necessarily limited to, the following. Detailed requirements of the Work are described in the pertinent specification Sections and/or shown on the Drawings.
- B. General Construction (.1) Contract:
  - 1. Drawing Series G – General; C- Civil; L- Landscape; S – Structural; A – Architectural; and QK – Equipment Kitchen.
  - 2. Specifications: Divisions 01 through 14 and Divisions 31, 32 and applicable Sections of Division 33
- C. HVAC Construction (.2) Contract:
  - 1. Drawing Series M – Mechanical.
  - 2. Specifications: Divisions 01, 23 and applicable Sections of Divisions 02, 03, 05, 07, 09, 25, 31, 32 and 33.
- D. Plumbing Construction (.3) Contract:
  - 1. Drawing Series FP – Fire Protection and P - Plumbing
  - 2. Specifications: Divisions 01, 21, 22 and applicable Sections of Divisions 02, 03, 05, 07, 09, 25, 31, 32 and 33.



E. Electrical Construction (.4) Contract:

1. Drawing Series FA – Fire Alarm; E – Electrical; T – Telecom; TA – Audiovisual; and TY – Security.
2. Specifications: Divisions 01, 25, 26 and applicable Sections of 02, 03, 07, 08, 31, 32, and 33.

1.6 SPECIFICATION FORMAT

- A. The Specifications for the work of the separate prime Contracts are bound in one volume. Technical provisions which apply to each prime Contract are included in the Divisions listed below:
- B. General Construction (.1) Contract: Divisions 01 through 14 and Divisions 31, 32 and applicable Sections of Division 33
- C. HVAC Construction (.2) Contract: Divisions 01, 23 and applicable Sections of Divisions 02, 03, 05, 07, 09, 25, 31, 32 and 33.
- D. Plumbing Construction (.3) Contract: Divisions 01, 21, 22 and applicable Sections of Divisions 02, 03, 05, 07, 09, 25, 31, 32 and 33.
- E. Electrical Construction (.4) Contract: Divisions 01, 25, 26 and applicable Sections of 02, 03, 07, 08, 31, 32, and 33.

Note: The term Professional refers to the Architectural or Engineering firm retained by the Department to design and document the work of the Project, or the Professional's authorized representative. The term Professional may also refer to the Client Agency if the Project design was delegated to the Client Agency. Throughout the Specifications and Drawings wherever the terms 'A/E', 'Architect' or 'Engineer' are used it shall mean Professional.

1.7 WORK BY OTHERS

- A. Not Applicable.

1.8 QUESTIONS DURING BIDDING PERIOD

- A. Direct all questions pertaining to the Project to the Project Professional utilizing the e-Builder Enterprise Software Program (e-Builder) as described in the Instructions To Bidders.

**PART 2 – PRODUCTS (Not Used)**

**PART 3 – EXECUTION (Not Used)**

**END OF SECTION**

**SECTION 01 02 50**  
**UNIT PRICES IN LUMP SUM CONTRACTS**

**PART 1 – GENERAL**

1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 DEFINITIONS

- A. Unit Price: An amount bid by the Contractor for a unit quantity of a work item listed in the Schedule of Unit Prices.
- B. Schedule of Unit Prices: The schedule of work items in the Contract for which the Contractor is to provide a price for adjusting the Contract amount for changes in quantity of work required.

1.3 PROCEDURES

- A. Unit Prices will be used as the basis for computing "additions to" or "deductions from" the Lump Sum Contract amount for extra work and for reductions in quantities of work called for by the Contract Documents. The unit price applied for "Adds" to the bid quantity will be equal to the unit price applied for "Deducts" to the bid quantity for each item listed. Unit Prices shall remain binding and irrevocable for the entire period of the Contract.
- B. Unit Prices shall include all costs by the Contractor, his suppliers and subcontractors for the work, including labor, material, tools, equipment, insurance, taxes, field overhead, general overhead and profit and bond. The work shall include all incidental items required to complete the work.
- C. The Department will not be bound by the Unit Prices unless it accepts the same by indication on the Construction Contract. The Department may award the contract without accepting the bidder's Unit Prices. If the Department and the Contractor are unable to agree upon a new Unit Price, the Department may at its discretion, direct the Contractor to perform such work on a force account basis.
- D. Work added to the Contract will be of the same general character as that required by the Contract Documents. Contractors are to assume that changes will be made in a timely manner, not requiring the Contractor to incur additional mobilization or other disproportional expenses in connection with the adjustment in contract quantities.
- E. Each bidder shall carefully check the drawings and specifications for the Base Bid quantities required to be included under the Contract.
- F. Contractors are to comply with requirements of the Instructions to Bidders and instructions for completion of the Bid Form.

1.4 SCHEDULE OF UNIT PRICES

- A. The following Schedules of Unit Prices apply to the Contracts indicated on the Schedules. The Contractor is to provide Unit Prices for all items.

GENERAL CONSTRUCTION (.1) CONTRACT – SCHEDULE OF UNIT PRICES			
ITEM NO.	DESCRIPTION	UNIT OF MEASUREMENT	QUANTITY IN LUMP SUM BID

1	Grout Injection (grouting at 25% of the initial and secondary locations)	CY	150
2	Initial Proof Drilling at 127 Locations (average 40-ft. deep with 10-ft. penetration into rock)	FT	5,080
3	Proof Drilling of 52 Secondary Grout (average 40-ft. deep with 10-ft. penetration into rock)	FT	2,080

1.5 CHANGES

- A. All changes in the quantity of work for which there is a Unit Price will be authorized using change order procedures provided in the General Conditions. Change Orders shall be written prior to performing the work where possible but may be written after the work is authorized, completed and measured when quantities are not able to be determined in advance.

1.6 MEASUREMENT

- A. Measurement of the work quantities where the work is performed prior to issuance of a Change Order shall be net quantities and not include cutting waste, or other adjustments to the unit of measure of the Unit Price. The Department and Contractor shall arrive at a rational procedure for measurement prior to performing the work. The Contractor shall be responsible for measurement and will submit the calculations and worksheets to the Department for approval.

1.7 DESCRIPTIONS OF UNIT PRICES

- A. General Construction (.1) Contract:
1. Unit Price 1: Grout Injection
  2. Unit Price 2: Initial Proof Drilling
  3. Unit Price 3: Secondary Proof Drilling

**PART 2 – PRODUCTS (Not Used)**

**PART 3 – EXECUTION (Not Used)**

**END OF SECTION**

**SECTION 01 03 00**  
**BASE BID DESCRIPTIONS**

**PART 1 – GENERAL**

1.1 STIPULATIONS

- A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 - General Requirements” form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SECTION INCLUDES

- A. This Section includes identification of each Base Bid and description of the changes to be associated with each Base Bid.

1.3 DESCRIPTION OF SEPARATE BASE BIDS

A. GENERAL CONSTRUCTION CONTRACT (DGS C- 0969-0017 PHASE 1.1)

1. Base Bid No. 1:

- a. Shall include all the work indicated on the Contract Drawings and described in the Contract Specifications except that work specifically called out as being part of another Base Bid. Clarification against Base Bids 2 and 3:
1. Courtyards: Initial 50% of Paving and Landscaping.
  2. First Emergency Power Generator and all related electrical systems in building to support both emergency power generators.
  3. New Trees across the site: Initial 25% of trees on site, not including the riparian buffer area, all trees in buffer are part of Base Bid 1.
  4. Flags at Veteran’s Plaza part of Base Bid 1.

2. Base Bid No. 2:

- a. Same as Base Bid No. 1, except add
1. Veteran’s Plaza (East Side, First Floor): Paving and Landscaping.
  2. Main Entrance Canopy (North Entrance, First Floor)
  3. South Parking Lot
  4. Veteran’s Entrance (West Entrance, Second Floor): Landscaping
  5. Courtyards: Remaining 50% of Paving and Landscaping.
  6. Second Emergency Power Generator
  7. New Trees across the site: additional 25% of trees on site, not including the riparian buffer area.

3. Base Bid No. 3:

- a. Same as Base Bid No. 2, except add
1. Veterans Plaza (East Side, First Floor): Canopy
  2. Veterans Entrance (West Side, Second Floor): Drop-Off Canopy and Covered Walk to Veterans Entrance.
  3. Shade Structures in Courtyards, total of four (4).
  4. New Trees across the site: additional 50% of trees on site, not including the riparian buffer area.

B. HVAC CONSTRUCTION CONTRACT (DGS C-0969-0017 PHASE 1.2)

1. Base Bid No. 1:
  - a. Shall include all the work indicated on the Contract Drawings and described in the Contract Specifications except that work specifically called out as being part of another Base Bid.
2. Base Bid No. 2:
  - a. Same as Base Bid No. 2.
3. Base Bid No. 3:
  - a. Same as Base Bid No. 3.

C. PLUMBING CONSTRUCTION CONTRACT (DGS C-0969-0017 PHASE 1.3)

1. Base Bid No. 1:
  - a. Shall include all the work indicated on the Contract Drawings and described in the Contract Specifications except that work specifically called out as being part of another Base Bid.
2. Base Bid No. 2:
  - a. Same as Base Bid No. 2.
3. Base Bid No. 3:
  - a. Same as Base Bid No. 3.

D. ELECTRICAL CONSTRUCTION CONTRACT (DGS C-0969-0017 PHASE 1.4)

1. Base Bid No. 1:
  - a. Shall include all the work indicated on the Contract Drawings and described in the Contract Specifications except that work specifically called out as being part of another Base Bid.
2. Base Bid No. 2:
  - a. Same as Base Bid No. 2
3. Base Bid No. 3:
  - a. Same as Base Bid No. 3

**PART 2 – PRODUCTS (Not Used)**

**PART 3 – EXECUTION (Not Used)**

**END OF SECTION**

**SECTION 01 04 00**  
**COORDINATION AND CONTROL**

**PART 1 – GENERAL**

1.1 STIPULATIONS

- A. The specifications sections " General Conditions of the Construction Contract ", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SECTION INCLUDES

- A. This section includes the on-site provisions that govern the performance of the work to complete this Project.

1.3 CONTRACTS - FOR THIS PROJECT CONSTRUCTION

- A. DGS C-0969-0017 PHASE 1.1 General Construction (Lead Contractor)
- B. DGS C-0969-0017 PHASE 1.2 HVAC Construction
- C. DGS C-0969-0017 PHASE 1.3 Plumbing Construction
- D. DGS C-0969-0017 PHASE 1.4 Electrical Construction

1.4 VISIT TO SITE

- A. For access to the site during the bidding period contact the Client Agency site personnel with phone number listed below:
  - 1. Client Agency Site Representative: Matt Smearman
  - 2. Telephone Number: (814) 696-5103

1.5 UNIDENTIFIED HAZARDOUS MATERIALS (ASBESTOS, CHEMICALS, ETC.)

- A. There is a possibility that hazardous materials not identified in the contract documents may be discovered on this project. Should it be determined that some or all of the hazardous materials must be removed, the Contractor shall obtain an estimate for said removal from a Subcontractor who is experienced in the field, has insurance and is knowledgeable of the regulations as they apply. The Contractor may provide the estimate itself if it is qualified in the applicable hazardous materials field. The Department shall consider authorizing a Change Order for the removal of the hazardous material to the extent necessary.
- B. The Contractor or Subcontractor must comply with all requirements of the General Conditions, including the maintenance of insurance up to the limit required under the General Conditions.
- C. Should a hazardous material be encountered on the job, the Contractor shall comply with all statutes and regulations of the Commonwealth of Pennsylvania and all rules and regulations of the United States Environmental Protection Agency as they apply during construction and demolition work and the disposal of hazardous material. Particular attention is drawn to Code of Federal Regulations, Title 40, Part 61, Section 112 of Clean Air Act and PA Department of Labor and Industry, Act 194 for asbestos.

- D. The Contractor shall comply fully with the regulations of OSHA as they pertain to the protection of workers exposed to the emission of asbestos fibers, chemicals, etc. and shall take all steps necessary to protect its employees, as well as all other people occupying the building.
- E. Whenever a hazardous material is to be removed or disposed of, the Contractor is required to make proper notification to the Bureau of Air Quality in the PA Department of Environmental Protections' Regional Office, PA Department of Labor and Industry and EPA as applicable, and is required to obtain and pay for any permits required. Disposal shall conform to all applicable regulations and documentation shall be required when, applicable.

1.6 LEAD PAINT (Not Applicable)

1.7 MOLD

- A. In the event mold is encountered, the Contractor shall implement corrective actions to protect workers, other building occupants, and to prevent the disturbance of mold in affected areas. Although not presently regulated by EPA and/or OSHA, the EPA does provide industry standards regarding worker safety and abatement procedures, which are the minimum procedures to be followed if mold is encountered.
- B. Any mold that appears as a result of construction shall be abated immediately by the Contractor responsible for this condition. The affected surface shall be cleaned, removed, and replaced. Inspection and testing shall be done by a qualified testing agency to confirm the mold has been removed in its entirety.

1.8 TESTING OF EQUIPMENT

- A. After any equipment furnished under the contract and any permanent heating, ventilating, plumbing, drainage or electrical systems and equipment have been installed or modified, it shall be the responsibility of the Contractor to operate its equipment for a satisfactory period of time, as required by the Department for proper testing and instructing the operating personnel. Fuel, electricity and water required for proper testing of permanent equipment and for the period of instructing personnel, shall be paid for by the Contractor testing its equipment.

1.9 PROJECT PHOTOGRAPHS

- A. Project Photographs not required.

1.10 INSTRUCTIONS AND TRAINING

- A. Refer to the General Conditions of the Construction Contract, as specified in the applicable technical portion of each specification for "Operations and Maintenance Instruction Manuals" and "Record Drawings" requirements.
- B. Unless approved by the Department, training shall not be scheduled/conducted until Record Drawings, Operation and Maintenance Instruction Manuals, valve tag lists, equipment and piping system identification, and all software programming is complete.
- C. Provide full on-site training and instruction to designated Commonwealth personnel given by competent manufacturer's authorized personnel thoroughly familiar with all technical and operational aspects of the installed items. Instructions are to cover operation and maintenance of all systems, equipment components and other items as specified and furnished under this contract. Instructional digital video recordings may be used to augment required instructions and training but may not be substituted for the in person on-site training. All on-site training



shall be digitally recorded by the Contractor. The digital video files are to be turned over to the Client Agency.

- D. Contractor shall provide an outline of the training and course content, which shall be submitted and accepted by the Professional and the Department prior to conducting training.
- E. Conduct instruction and training during regular working hours. For training on complicated systems, allow at least one-half of the training time to be at and/or with the system equipment.
- F. Provide additional training and instructions for all significant modifications and/or changes made under the terms and/or conditions of the manufacturer's and/or Contractor's warranty.
- G. The Contractor shall maintain and submit a sign-in list that clearly documents all personnel attending the training.

#### 1.11 PROJECT SIGN

- A. Provide a Project Sign. Refer to the General Conditions of the Construction Contract.

#### 1.12 REUSE OF MATERIALS

- A. No removed materials or equipment shall be reinstalled in the work, unless so noted on the Drawing or in these Specifications.

#### 1.13 GENERAL

- A. All construction trailers, offices, equipment and materials required to be on-site shall be located as shown on the Drawings, or at the direction of the Department.

#### 1.14 WORKING HOURS

- A. The Contractor's available working hours shall be from 7 A.M. to 5 P.M., Monday through Friday.
- B. Work during different hours, or work on Saturdays, Sundays, State and National Holidays or overtime work, must have the Regional Director's or his designee's prior written approval. Work on these days if approved shall be at no additional cost or time to the Contract.
- C. This shall not apply in those unforeseen isolated and/or emergency instances when a particular operation must be performed in a continuous sequence that extends the working day beyond the approved working hours. Coordinate with the Department in these instances.
- D. The Department's failure to approve different working hours, weekend or holiday working hours, or overtime hours is not cause for a claim against the Department for delay or any added costs or time to the Contract.
- E. Utility shut-downs required for tie-ins to existing systems shall be done in off-hours, weekends, and/or holidays to minimize the impact on the operations of the Client Agencies (and/ or surrounding buildings). These costs shall be anticipated and included in the Contractor's bid. Contractors are to follow all requirements stated in Articles 6.21 and 6.22 of the General Conditions and submit the "Utility Shutdown Checklist" form accessed through the e-Builder Forms Module for approval. Forms are located under the Project Menu along the left column of e-Builder. The "Utility Shutdown Checklist" form is listed under Workflow Forms within the "All Workflow and Static Forms" drop-down menu.

#### 1.15 DELIVERY, STORAGE AND HANDLING

- A. Prefinished materials shall arrive at job site in their original unopened cartons or other protective packaging necessary to protect finishes. Materials shall be stored in such packages until time of application. Flat materials such as panels shall arrive and remain on adequate support to ensure flatness and prevent damage.
- B. Store all materials, equipment and bulk items prior to installation in clean, dry, well ventilated locations away from uncured concrete, masonry or damage of any kind. Waterproof tarpaulin or polyethylene sheeting must allow for air circulation under covering.
- C. Coordinate storage location with the Department.
- D. Refer to each section for specific delivery, handling and storage instructions of items specified.

#### 1.16 PARKING

- A. Parking shall be limited to areas indicated on the Site Plans. All parking is subject to prior approval of the Department and Client Agency.

#### 1.17 TRAFFIC

- A. The Lead Contractor shall establish at the Initial Job Conference a construction staging and traffic plan for the project which minimizes the construction interference with the Client Agency's operation. This plan is subject to the Department's and the Client Agency's review and acceptance. This acceptance does not relieve the Contractors of their responsibilities regarding safety coordination, and adherence to all traffic laws and ordinances.

#### 1.18 SUBSURFACE INFORMATION

- A. Any available data concerning subsurface materials or conditions based on soundings, test pits or test borings, has been obtained by the Department for its own use in designing this Project. The Test Boring logs are incorporated into the construction contract as a Contract Document. However, the Geotechnical Report with all other exhibits is provided for information purposes only; it is not to be relied upon or included in the construction contract as a Contract Document. The Report is available to Bidders but the Bidders must agree and acknowledge that the information and recommendations in the Report are not warranted for accuracy, correctness or completeness, and is not incorporated as a Contract Document.
- B. Test Boring logs reflect the conditions at the specific locations of each test boring only. The Contractor accepts full responsibility for any conclusion drawn with respect to conditions between test borings. Bidders shall therefore undertake to perform their own investigation of existing subsurface conditions. The Department will not be responsible in any way for the consequences of the Contractor's failure to conduct such an investigation. Excavation for the Project is "Unclassified" as fully described in the Earthwork Section.

#### 1.19 SITE FENCE

- A. See Civil Drawing C-201 for the extent of the site fence.

#### 1.20 ENVIRONMENTAL QUALITY CONTROL

- A. The Prime Contractor and its Subcontractors shall perform their work in a manner which shall minimize the possibility of air, water, land and noise pollution, in accordance with the General Conditions of the Construction Contract.
- B. The name, address and telephone number of the Department of Environmental Protection Regional Office is furnished below. This office shall be contacted for waste disposal permits and for information concerning sites already approved for conducting waste disposal.

Southcentral Regional Office  
909 Elmerton Avenue  
Harrisburg, Pa. 17110-8200  
(717) 705-4700

Counties: Adams, Bedford, Berks, Blair,  
Cumberland, Dauphin, Franklin,  
Fulton, Huntingdon, Juniata,  
Lancaster, Lebanon, Mifflin,  
Perry, and York

#### 1.21 OFFICE FOR CONTRACTOR

- A. Each Prime Contractor shall provide and maintain, at its cost, a suitable office on the premises, at a location shown on the Lead Contractor's accepted staging plan. The Contractor shall provide and maintain heating facilities and supply fuel for same in cold weather and shall remove the office from the premises at completion of all work. Provide electrical, telephone and internet service.

#### 1.22 DGS CONSTRUCTION PROJECT COORDINATOR OFFICE

- A. The Lead Contractor shall prepare a drawing of the DGS Construction Project Coordinator Office along with proposed arrangement of the Contractor's Office and construction staging area for the Department's approval. An electronic copy in .pdf format of the sketch plan is to be submitted through e-Builder to the Department within 7 calendar days of Effective Date of Contract or issuance of Letter of Intent whichever occurs first.
- B. The Lead Contractor shall furnish, within five (5) days of the Department's approval of the Lead Contractor's drawing, a suitably finished mobile office of at least 720 square, including the necessary extension or provisioning of utilities and service lines required for its proper operation. The Lead Contractor shall clean this office at least bi-weekly, maintain and pay all utility bills, for the duration of the Project, through the completion of all punch list items (unless directed otherwise by the Department). The Lead Contractor shall remove the office from the premises when directed by the Department. The office shall be suitably partitioned as directed by the Department and shall include:
  - 1. Heating and Air-Conditioning
  - 2. Screened and locking high security windows with bars, on at least two (2) sides, provided with adequate window blinds
  - 3. Locking high strength steel, high security doors with high quality deadbolt door locks, complete with entrance steps and up to four (4) sets of keys
  - 4. Lighting and electrical receptacles of suitable number and capacity
  - 5. One (1) Restroom with water closet, and lavatory with hot and cold water and sanitary service.
  - 6. A first quality mercury thermometer on outside of the DGS Construction Manager Office which records the high and low temperature for the day
  - 7. The Lead contractor shall arrange for all electrical power hook-up/service (as well as water and sanitary, if required), and shall be responsible for all cost necessary to provide these services to the DGS Construction Manager Office (including monthly utility costs). A temporary electric service shall be ordered from the utility provider. If the temporary electrical service is not readily available from the utility provider, a temporary generator shall be provided and maintained (including fuel) until such time power can be established.)
  - 8. The Lead Contractor to install (4) 9'x20' parking spaces directly adjacent to the DGS Construction Manager Office location. Specific location of parking spaces to be coordinated with Constuction Project Manager.
  - 9. Sanitary holding tank (to accommodate item 5 above) with capacity for three persons for a week, plus one weekly meeting with 12 persons. Tank shall be protected from freezing. Tank shall be emptied on weekly basis, more often if needed. Contractor shall arrange and be responsible for all cost necessary to provide this service to the field office (including all pickup and dump charges).

10. Domestic water holding tank with the same capacity as item 9 above (sized accordingly), to accommodate item 5 above.

C. Equipment: The Lead Contractor shall furnish, with the DGS Construction Project Coordinator Office, the following items in the quantity indicated and remove same from the premises when directed by the Department. The Lead Contractor shall maintain all items in good condition and furnish all supplies (i.e., toner, paper, bottled water, drinking cups, bathroom supplies) for the duration of the Contract. If any equipment fails, it shall be repaired or replaced by the Lead Contractor within twenty-four (24) hours of being notified by the Department.

The specified IT hardware/peripherals shall be compatible with the HP Revolve 810 EliteBook and include all required battery chargers, data cables (including HDMI), software, ect. to provide a fully integrated and functioning system.

1. 3 Desk(s) with swivel chair(s)
2. 0 Electronic calculator
3. 1 Plans rack(s), plan rack shall include required quantity of plan sticks to fully utilize the plan rack
4. 1 Plans table(s) with stools
5. 0 Four (4) drawer file cabinet(s)
6. 2 12" deep shelving units of thirty (30) lineal feet
7. 3 Six (6) foot table(s)
8. 16 Chair(s)
9. 1 Clothes tree or closet with rod
10. 1 Provide an all in one print/copy/scan/fax machine capable of producing 35 pages per minute double sided on 8-1/2"x11" and 11"x17". Machine shall be wireless capable and network capable and print/copy/scan/fax both in color and black and white
11. 3 Safety glasses
12. 1 Fire Extinguisher
13. 1 First-Aid Kit
14. 1 Water cooler, with hot and cold taps
15. 0 Telephones (cordless, with speaker phone capabilities), and answering machine.
16. 4 Trash cans

IT Hardware/Peripherals:

17. 4 Computer monitor(s) - basis of design - Hewlett Packard ProDisplay P232 - 23"
18. 2 Keyboard - basis of design - Hewlett Packard KU-1156
19. 2 Docking station with all associated cables for connection of all peripheral devices to support the Hewlett Packard Revolve 810 - Basis of design - HP 2013 UltraSlim Docking Station.
20. 2 Mouse - optical mouse with USB cord, dual button and scroll wheel – Basis of design - Hewlett Packard
21. 1 55" High Definition LED flat panel monitor with wall mount bracket and remote. Monitor shall be network/wireless capable, 120Hz, 1080P.
22. 1 Wireless connectivity to the 55" High Definition LED flat panel monitor shall be accomplished with a wireless receiver and transmitter – Basis of design - ScreenBeam Mini2 wireless receiver (Catalog # SBWD60A01) and a ScreenBeam USB Transmitter 2 (Catalog # SBWD200TX02).
23. 1 4'x3' white marker board with (2) sets of markers of standard color.
24. 1 12 Month Wall Calendar - 20"x30" - Basis of design AT-A-GLANCE, Model #PM4-28-17

Other Items:

25. 2 Plain white ANSI approved hardhats

26. 2 Rubber muck boots

- D. The DGS Construction Project Coordinator Office shall be equipped by the Lead Contractor with telephone cabling and jacks to connect one (1) telephone voice line for use by DGS Personnel. The Lead Contractor shall provide up to four (4) modular telephone jacks (RJ-11 connectors) in the main office area in locations indicated on the approved office plan accepted by the Department for use with the Contractor provided phones. The Lead Contractor will install telephone cable to connect each jack to the demarcation point where the local telephone company provides service (utility pole, telephone room or other access point). The Lead Contractor shall place orders to the local telephone company to activate line service and pay for the service and monthly charges.
1. The Lead Contractor shall provide three (3) data/phone jacks in locations indicated on the approved office plan accepted by the Department for use with the Department's computer(s) and Contractor provided phones. The Lead Contractor shall provide a Broadband Internet service and pay all connections/disconnection and monthly fees. The Lead Contractor shall further provide Wi-Fi access utilizing WPA2 security. Options include cable modem, DSL, Satellite or similar service (dial up is not acceptable). The wireless access point should be positioned to provide sufficient coverage in the DGS Construction Managers Office space. The contractor shall provide usernames/passwords for authorized wireless users as determined by the DGS Construction Project Manager.
  2. It shall be the Lead Contractor's responsibility to ascertain the means in which the Broadband Internet source will be provided. Internet download and upload speeds of 100Mbps shall be provided at all times. The Internet source must be coordinated with the DGS Construction Project Manager to assure compatibility with the Department's hardware/software requirements. Wireless access point shall be made fully operational and maintained by the Contractor. At the Department's sole discretion 4G LTE wireless hotspot internet service may be acceptable.

1.23 SANITARY FACILITIES

- A. The Lead Contractor shall, at its cost, provide and maintain in a clean and sanitary condition, adequate and approved sanitary facilities in accordance with O.S.H.A. requirements. All facilities shall be screened against insects. When directed by the Department, the Contractor shall dismantle and remove these facilities and disinfect as required. Portable chemical toilets approved by the Pennsylvania Department of Health are acceptable. Under temporary field conditions, provisions shall be made to assure not less than one toilet facility is available.

1.24 SMOKING POLICY

- A. Smoking and use of smokeless-tobacco, chewing tobacco, snuff, Vape machines and similar paraphernalia are strictly prohibited in all buildings.

1.25 CONCRETE AND EARTHWORK

- A. All Contractors shall perform concrete work and earthwork required for their work, and shall comply with applicable Division 2, 3, 31, 32, and 33 sections. If any specification section contains language conflicting with requirements of applicable Division 2, 3, 31, 32, and 33 sections, the most stringent requirements shall prevail.

1.26 QUALITY CONTROL TESTING

- A. Structural-related testing and inspections required to be performed by the Contractor(s) are listed in Section 014000 – Quality Control Testing Services. If Quality Control testing or inspections required appear in Section 014000 and in a technical section, the most stringent requirements shall prevail. If Quality Control testing or inspections required appear in a technical section and not in Section 014000, they shall be required as if specified in Section 014000. Conditions pertaining to Quality Control testing and inspections may appear in the

technical sections. All testing herein is to be by the Contractor. Testing by the Department, Quality Assurance Testing, is for the purpose of checking the results of the Contractor's Quality Control Testing. Testing is to be by the Contractor, unless specifically stated to be "by the Department" or required by Section 014010 – Quality Assurance Testing and Inspection Services.

- B. Non-structural testing is in the technical specifications.

#### 1.27 CADD FILE WAIVER

- A. The Professional will make graphic portions of the bid drawings available for use by the Contractor by uploading files to e-Builder.
- B. Electronic files shall be uploaded only after all construction contracts have been executed.
- C. The files are provided as a convenience to the Contractor, for use in preparing shop drawings and/or coordination drawings related to the construction of this Project only. These files and the information contained within are the property of the Department, and may not be reproduced or used in any format except in conjunction with this Project.
- D. The Contractor acknowledges that the information provided in these files is not a substitution or replacement for the Contract Documents and does not become a Contract Document. The Contractor acknowledges that neither the Professional nor the Department warrant or make any representation that the information contained in these files reflect the Contract Documents in their entirety. The Contractor assumes full responsibility in the use of these files and acknowledges that all addenda, clarifications and changes to the drawings executed as a part of the Contract Documents may or may not be incorporated in these electronic files.
- E. The Contractor acknowledges that the furnishing of these files in no way relieves the Contractor from the responsibility for the preparation of shop drawings or other schedules as set forth in the Contract between the Contractor and the Department.
- F. The electronic documents shall be stripped of the Professional's name and address, and any professional licenses and signatures indicated on the contract documents. Use of these electronic documents is solely at the Contractor's risk, and shall in no way alter the Contractor's Contract for Construction.
- G. Disclaimer: The Professional and Department make no representation regarding fitness for any particular purpose, or suitability for use with any software or hardware, and shall not be responsible or liable for errors, defects, inexactitudes, or anomalies in the data, information, or documents (including drawings and specifications) caused by the Professional's or its Consultant's computer software or hardware defects or errors; the Professional's or its Consultant's electronic or disk transmittal of data, information or documents; or the Professional's or its Consultant's reformatting or automated conversion of data, information or documents electronically or disk transmitted from the Professional's Consultants to the Professional.
- H. By the Contractor's or their subcontractor's use of the electronic files (e.g., AutoCAD files), the Contractor and their subcontractor waive all claims against the Department the Professional, its employees, officers and Consultants for any and all damages, losses, or expenses the Contractor incurs from any defects or errors in the electronic documents. Furthermore, the Contractor shall indemnify, defend, and hold harmless the Department, the Professional, and its Consultants together with their respective employees and officers, from and against any claims, suits, demands, causes of action, losses, damages or expenses (including all attorney's fees and litigation expenses) attributed to errors or defects in data, information or documents, including drawings and specifications.

#### 1.28 DELEGATED DESIGN SERVICES

- A. Performance and Design Criteria: Where design services or certifications by a design professional are specifically delegated to the Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated in the technical specification sections.
  - 1. If criteria indicated in the technical sections are not sufficient to perform services or certification required, submit a written request for additional information to the Professional.
- B. Delegated Design Services Submittals: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement signed and sealed by the responsible design professional registered in the Commonwealth of Pennsylvania, for each product and system specifically assigned to the Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

## 1.29 COORDINATION DRAWINGS

- A. General:
  - 1. Refer to the General Conditions of the Construction Contract regarding the preparation of Coordination Drawings and the responsibilities of all Prime Contractors. Any conflicts between or questions regarding the requirements in this Section and the requirements in the General Conditions should be brought to the attention of the Professional.
  - 2. Refer to Technical Specification sections for specific Coordination Drawing requirements for mechanical and electrical installations. Other Technical Specifications sections may also identify requirements for Coordination Drawings.
  - 3. The Prime Contractors shall indicate the value of this effort as a line item on the Schedule of Values.
  - 4. Submission of Coordination Drawings shall be included as a milestone on the Construction Schedule. The General Contractor shall initiate this action and acquire the necessary dates from the other Prime Contractors as part of their overall scheduling responsibilities.
  - 5. Coordination drawings shall be completed within (60) calendar days of the Effective Date of the Contract.
  - 6. The Department's receipt of Coordination Drawings does not in any way constitute approval, or relieve the Prime Contractors of the responsibility to accurately coordinate and install their work.
- B. Coordination Procedures:
  - 1. The HVAC Contractor shall have the lead role in this process and shall initiate Coordination Drawings by producing background drawings in electronic format. Electronic drawing files will be available in e-Builder to all Prime Contractors. These background drawings shall include walls, partitions, structural elements, finished floor elevations, dimensions, ductwork, piping, conduit, system devices, associated equipment, etc.
  - 2. Electronic drawings shall then be forwarded to the other Prime Contractors, one at a time, including the General Contractor, for inclusion, layout and interface of all relative equipment, material and penetrations associated with the Work.
  - 3. Each Prime Contractor is responsible for the accuracy and completeness of all Coordination Drawings and shall review all other Prime Contractor's drawings so that there will be no interference and/or conflict with its portion of the work.
  - 4. Upon completion of the preliminary Coordination Drawings, the HVAC Contractor shall schedule a coordination meeting with all Prime Contractors in order to resolve all interference issues. Altering structural elements, bearing elevations, established dimensions, partition locations and ceiling/bulkhead heights or any other aesthetic effect is prohibited without the consent of the Professional.

5. Upon resolution of all interference issues, the Coordination Drawings shall be revised as required, and upon acceptance by all Prime Contractors, the HVAC Contractor will upload the final Coordination Drawings to e-Builder.
    - a. Coordination Drawings shall contain a signature block for each Prime Contractor to provide signatures and dates indicating concurrence.
  6. Coordination Drawings may be formulated and submitted in partial submittals to facilitate the construction schedule and sequence of work within the Project. This must be agreed to by all Prime Contractors and a priority of sequence must be established that has the concurrence of all parties, including the Department. Approval of partial sets of Coordination Drawings shall not relieve the Contractors of their responsibility for properly coordinating work appearing in subsequent submissions. Any revisions to subsequent work necessitated by such partial approvals shall be performed at no additional cost to the Department.
- C. Coordination of Work:
1. Each Prime Contractor shall clearly show, and coordinate with the other Prime Contractors, the following:
    - a. Arrange for pipe spaces, chases, slots, sleeves, and openings with general construction work, and arrange in building structure during progress of the Work, to allow for and facilitate distribution line and equipment installation.
    - b. Coordinate installation of required supporting devices for ductwork, piping, and conduit, as well as sleeves, and other structural components, as they are constructed.
    - c. Coordinate requirements for access panels and doors for HVAC, Plumbing and Electrical items requiring access where concealed behind finished surfaces.
    - d. Coordinate electrical connections to equipment provided by all Contractors.
    - e. Sequence, coordinate, and integrate installing materials and equipment for efficient flow of the Work. Coordinate installing large items of equipment requiring positioning before closing in the building.
  2. Each Prime Contractor shall coordinate its construction operations with those of other Prime Contractors and entities to ensure efficient and orderly installation for each part of the Work. Each Prime Contractor shall coordinate its operations with other operations, included in different Sections that depend on each other for proper installations, connection, and operation. All Prime Contractors shall:
    - a. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
    - b. Coordinate installation of all components with other Prime Contractors to ensure adequate accessibility/clearance for required maintenance and service.
    - c. Make provisions to accommodate items scheduled for later installation.

#### 1.30 PERMIT CONDITIONS

- A. PA Department of Health
  1. Contractor to submit Sprinkler Shop Drawings.
- B. NPDES, Pennsylvania Department of Environmental Protection.
  1. Pre-Construction meeting.
  2. Weekly inspections.

#### **PART 2 – PRODUCTS (Not Used)**

#### **PART 3 – EXECUTION (Not Used)**



**END OF SECTION**

**SECTION 013100**  
**SEQUENCE OF CONSTRUCTION AND MILESTONES**

**PART 1 – GENERAL**

1.1 STIPULATIONS

- A. The specifications sections " General Conditions of the Construction Contract ", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 GENERAL REQUIREMENTS

- A. Before beginning work, the Contractor will be required to prepare a schedule in consultation with the Department. The work must be carried out in full accordance with the schedule. The Contractor shall arrange to perform the work without any unnecessary interference with the Institution's operation.

1.3 CRITICAL MATERIALS AND EQUIPMENT

- A. The Contractor is cautioned that all necessary and required critical materials and equipment shall be ordered as quickly as possible, in order that the shipping will not delay the progress of the work or completion of the project.

1.4 CRITICAL ITEMS TO BE NOTED AS MILESTONES

- A. Refer to the General Conditions, Article 8 'Project Schedule', regarding construction progress Milestones to be established by the Lead Contractor.
- B. The Contractor shall include the following critical items as Milestones:
  - 1. General Construction (.1) Contract:
    - a. Site Mobilization
    - b. Completion of Site Preparation
    - c. Footing and Foundation's Completion
    - d. Steel Frame Erection Completion
    - e. Slab Completion
    - f. Roofing Completion
    - g. Exterior Wall Framing Completion
    - h. Building Envelope Completion / Dry In
    - i. Completion of Interior Partitions
    - j. Completion of Interior Finishes
    - k. Completion of Exterior Finishes
    - l. Completion of Site Work
    - m. Completion of Landscaping
    - n. Final Inspections
    - o. Substantial Completion
    - p. Punch List Completion
  - 2. HVAC Construction (.2) Contract:
    - a. Shop drawing review for RTUs and other equipment.
    - b. Installation of vertical supply, return and exhaust duct risers per wing.
    - c. Installation of VAV terminals, exhaust fans and horizontal ductwork per wing. (Above ceiling inspections)
    - d. Installation of kitchen hood, exhaust and make up air ductwork and connections.

- e. Setting of RTUs and miscellaneous equipment on roof.
  - f. Startup of equipment, testing and commissioning.
  - g. Review of closeout documentation.
3. Plumbing Construction (.3) Contract:
- a. Completion of incoming gas, water services
  - b. Completion of Water Room: Piping, filters, booster pump etc.
  - c. Completion of Mechanical Room: Water heaters installed and piping complete.
  - d. Sprinkler Shop Drawing Review
  - e. Fire Protection Installation and testing
4. Electrical Construction (.4) Contract:
- a. Shop drawing review for electrical gear, generators, and other equipment.
  - b. Electrical gear approved by local power company prior to ordering of equipment.
  - c. Installation of electrical gear and generators.
  - d. Installation of panelboards in sub electric rooms.
  - e. Above ceiling inspection prior to ceilings being closed up.
  - f. Startup of generators and energizing of equipment, testing, and commissioning.
  - g. Lighting controls testing and commissioning.
  - h. Fire alarm testing and commissioning.
  - i. Final punchout inspection of entire project.
  - j. Review of closeout documentation.

#### 1.5 SEQUENCING OF CONSTRUCTION AND OTHER REQUIREMENTS

- A. The Project is an open site and there are no sequences of construction, outside of the normal path of construction.

#### **PART 2 – PRODUCTS (Not Used)**

#### **PART 3 – EXECUTION (Not Used)**

**END OF SECTION**

**SECTION 01 40 00**  
**QUALITY CONTROL TESTING SERVICES**

**PART 1 – GENERAL**

1.1 STIPULATIONS

- A. The specifications sections, "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 GENERAL

- A. The Contractor is responsible for verifying and enforcing compliance with all requirements of the Contract Documents. Contractor's responsibility includes, but is not limited to, the following:
  - 1. Supervision of field work to enforce contract compliance of all construction activity.
  - 2. Verification of compliance with plans and specifications of all manufactured materials or equipment. Provide certificates of compliance, or other approved proof of compliance, by the manufacturers and submit to the Professional.
  - 3. Performance of all necessary field measurements and/or inspections to verify compliance with requirements of the plans or specifications requiring adherence to measurable standards of field performance.
  - 4. Engaging an independent testing laboratory to perform tests and inspections as required by this specification section, hereafter referred to as Quality Control Testing and Inspection Services or Quality Control Testing Services.
  - 5. Providing support services for all Quality Control Services, including cutting and patching and repair or replacement as required.
- B. Work not included: Quality Assurance Services by the Department are specified in Section 014010. The Department reserves the right to perform tests under the Quality Assurance Testing program and to use those as the basis for approval or rejection at its sole discretion.

1.3 DESCRIPTION OF QUALITY CONTROL TESTING

- A. Quality Control Services include inspections, tests and reports by an independent testing laboratory or other approved agency, hereafter referred to as the Quality Control Agency. All Quality Control Services shall be at the Contractor's cost, which shall be included proportionally in all items of payment or contained in any Base Bid or Unit Price on the Proposal. Tests and Inspections are to include those specifically required by this section and within technical sections of the Project Manual.
- B. The Quality Control Agent shall submit a Testing and Inspection Plan to the Professional for its approval, and the approval of the Quality Assurance agent for all tests and inspections required by this section and within technical sections of the Project Manual.
- C. Quality Control Services by a Quality Control Agency or Agencies is intended to assist in the determination of probable compliance of the work with requirements specified or indicated and do not relieve the Contractor of the responsibility for compliance with Contract Document requirements.
- D. Specific testing or inspections of a structural nature required to be performed by independent Quality Control Agencies for individual construction activities are specified in this Section only. If testing or inspection requirements appear in this section and a technical section, the most stringent requirements shall prevail. If Quality Control Testing or Inspection is specified in a technical section and not in this section, it shall be required as if specified in this section. Non-structural tests and inspections are in the technical specifications.

- E. Inspections, tests and related actions specified are not intended to limit the Contractor's quality control procedures that facilitate compliance with Contract Documents requirements.
- F. Quality Control Services required by the local municipality or other governing authorities are the responsibility of the Contractor, regardless of whether or not specified hereinafter or in the applicable specification section.
- G. Each prime Contractor will pay for all costs in connection with its Quality Control Services. Whenever the word "Contractor" is used it shall be interpreted to mean Prime Contractor or Contractors as applicable. All Contractors performing work for which testing or inspection is required by this section are required to perform said tests/inspections appropriate for the quantity of work performed as indicated by this specification section and as required by all Contract Documents.

## **PART 2 – PRODUCTS (Not Used)**

## **PART 3 – EXECUTION**

### **3.1 RESPONSIBILITIES AND DUTIES OF CONTRACTOR**

- A. The Contractor shall engage Quality Control Agencies to provide all Quality Control Services required to comply with the Contract Documents. These services shall be at no cost to the Department.
- B. The Contractor is responsible for retesting where results of required inspections, tests or similar services prove unsatisfactory and indicate non-compliance with Contract Document requirements. Likewise, the Contractor is responsible for retesting when the Department's Quality Assurance Test results prove unsatisfactory. If Quality Assurance Tests were in error, the Contractor shall be reimbursed for his retesting costs.
- C. Cost of retesting construction revised or replaced by the Contractor is the Contractor's responsibility.
- D. Provide the Quality Control Agency with preliminary representative samples of materials to be tested in quantities requested. If the source, quality or characteristics of an approved material changes or indicates lack of compliance with Contract requirements, submit additional samples of materials to the Quality Control Agency.
- E. When requested by the Professional, the Department, or the Quality Control Agency, the Contractor shall immediately provide reports, cutting lists, material bills, shipping bills, time and place of shipment of materials to shop and field and any relevant data on previous testing and investigations of materials.
- F. Provide casual labor and facilities:
  - 1. To provide access to the work inspected or tested by any authorized party.
  - 2. To obtain and handle samples at the site.
  - 3. To facilitate inspections and tests by the Quality Control Agency or Quality Assurance Agency.
  - 4. For security and protection of samples and test equipment at the project site.
- G. To facilitate the timely sequence of inspection and testing, the Contractor shall give advanced notification to the Quality Control Agency and the Department that work has progressed to a point where inspection and testing may proceed.

- H. Contractor shall pay for additional cost of Quality Control Agency services which, in the opinion of the Professional and the Department, are required because of the following:
1. Failure of materials or workmanship to meet Contract requirements.
  2. Materials or practices not complying with the technical specifications which could possibly result in defective and unacceptable work.
  3. Changes in source, quality or characteristics of materials.
  4. Site cured concrete cylinders requested by the Contractor.
- I. The Quality Control Agency shall submit a certified written report of each inspection, test or similar service to the Design Professional, the Quality Assurance Agent, the Bureau of Construction Regional Director, Project Manager and Assistant Project Manager, and the Contractor, with additional copies directly to any governing authority when that authority so directs. All reports shall be uploaded to e-Builder within 24 hours of when the inspection occurs, test is conducted, test results obtained or similar service was conducted.
- J. Report Data: Written reports of each inspection, test or similar service shall include, but not be limited to:
1. Date of issue.
  2. Project title and number.
  3. Name, address and telephone number of testing agency.
  4. Dates and location of samples and tests or inspections.
  5. Names of individuals making the inspection or test.
  6. Designation of the Work and test method.
  7. Identification of product and specification section.
  8. Complete inspection or test data.
  9. Test results and an interpretation of test results.
  10. Ambient conditions at the time of sample taking and testing.
  11. Comments or professional opinion as to whether inspected or tested work complies with Contract Document requirements.
  12. Name and signature of Quality Control Agency inspector.
- K. The QC Agent shall cooperate in using standard forms/procedures developed by the Department that assist in accomplishing the tasks required.
- L. Engage independent testing laboratories, whose employees assigned to the Project and tests performed comply with ASTM E 329, Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction. The testing laboratory must be accredited and audited by a qualified national authority. The Contractor is to submit the name and credentials of the proposed QC Agent to the Design Professional and the Department for acceptance.
- M. Upon completion of inspection, testing, sample taking and similar activities, repair the damaged work and restore substrates and finishes to eliminate deficiencies, including deficiencies in the visual qualities of exposed finishes. Comply with the Contract Document requirements for "Cutting and Patching". Protect work exposed by or for Quality Control Testing activities, and protect repaired work.
- N. All required testing/inspection, including that stated in the body of the technical specification sections (be it referenced in the technical specifications as "Quality Control", "Quality Assurance", or any other referenced testing and/or inspection) shall be performed by the Contractor, unless it explicitly states it shall be performed by the Department. If stated to be performed by the Department, the Contractor shall still be required to perform all necessary testing/inspection in advance of the Department to assure the work meets all the requirements of the contract documents.

- O. Contractor shall coordinate closely with the Department, the Professional and the Professional's QA Agencies and Consultants so that any required or desired QA testing can be performed concurrently or immediately after the Contractor's QC testing.

### 3.2 RESPONSIBILITIES AND DUTIES OF QUALITY CONTROL AGENCIES

- A. Quality Control Agencies engaged to perform inspections, sampling and testing of materials and construction shall cooperate with the Professional, the Quality Assurance Agent, the Department, the Department of Labor and Industry, and the Contractor in performance of its duties, and shall provide qualified personnel to perform required inspections and tests. If it is determined by the Department that the personnel provided are not qualified or are not working in the best interests of the Project for the tests performed, the Contractor, through their Quality Control Agent, shall immediately replace or supplement the subject personnel.
- B. Quality Control Agencies shall notify the Department, the Quality Assurance Agent, the Professional, and the Contractor immediately of irregularities or deficiencies observed in the Work during performance of its services.

### 3.3 QUALITY CONTROL SERVICES TO BE PERFORMED

- A. Testing and inspections by the Quality Control Agency or Agencies shall include, but are not limited to, the following list.

## LIST OF TESTS AND INSPECTIONS

DESCRIPTION OF TEST OR INSPECTION	REFERENCED STANDARD	QUANTITY OR FREQUENCY
<b>BITUMINOUS PAVEMENT</b>		
Bulk Specific Gravity...of Compacted Bituminous Mixtures...	ASTM D1188 or D 2726	1 test
Density of Bituminous Concrete in Place by Nuclear Method	ASTM D2950	6 tests/1000sy paving
Thickness or Height of Compacted Bituminous Paving Mixture Specimens	ASTM D3549	3 tests/1000sy paving
<b>EARTHWORK<sup>1</sup></b>		
Laboratory Compaction Characteristics of Soil Using Modified Effort	ASTM D1557	One for each type and variation of cohesive soil to be compacted
Laboratory Compaction Characteristics of Soil Using Standard Effort	ASTM D698	One for each type and variation of cohesive soil to be compacted
Density of Soil and Soil-Aggregate In Place by Nuclear Methods	ASTM D6938	As often as required to ensure contract compliance
Inspect and comment on suitability of subgrades. Test footing excavations and paving subgrades regardless if it is native material or fill and record resultant foundation bearing capacity or compaction results as applicable.	N/A	As often as required to ensure the minimum required bearing capacity is present. Bearing Capacity tests must be witnessed and/or reviewed by the Department, Professional, Professional's Geotechnical Engineer or QA Agent.
Verify use of proper materials, densities and lift thicknesses during placement and compaction of compacted fill.	ASTM D6938	Continuous
Grouting: The Contractor shall provide at least one supervisory person, with a minimum experience of five years with similar work, who shall be present at all times during execution of the work and who shall be thoroughly familiar with the type of work being performed and its best methods for completion. This person shall have the authority to act on behalf of the Contractor.		
Rigid Inclusions: The Installer shall have a full-time, on-site Quality Control (QC) Technician to verify and report all installation procedures.		
<b>CONCRETE</b>		



DESCRIPTION OF TEST OR INSPECTION	REFERENCED STANDARD	QUANTITY OR FREQUENCY
Inspection of concrete formwork	ACI 301	shape, location, and dimensions of the concrete member being formed
Measure of floor and slab flatness and levelness	ASTM E1155	Continuous
<b>CAST STONE</b>		
Absorption of Architectural Cast Stone	ASTM C1195	1 Test
<b>MASONRY</b>		
Constructing and Testing Masonry Prisms Used to Determine Compliance with Specified Compressive Strength of Masonry (3 prisms/test)	ASTM C1314	1 Test
Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry, Annex A7 Compressive Strength (3 cylinders/test) (Contractor makes cylinders.)	ASTM C 780	1 Test/5000 units of masonry for each mortar type.
Sampling and Testing Grout (3 cubes/test) (Contractor makes cubes)	ASTM C1019	1 Test/25 CY grout.
Observation of any grout specimens and/or prisms	ACI 30.1/ASCE 6/TMS 602 Art 1.4	Continuous

DESCRIPTION OF TEST OR INSPECTION	REFERENCED STANDARD	QUANTITY OR FREQUENCY

Footnotes:

- 1. Refer to Earthwork Section for additional details.

END OF SECTION

**SECTION 01 40 10**  
**QUALITY ASSURANCE TESTING AND INSPECTION SERVICES**

**PART 1 – GENERAL**

1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 GENERAL

- A. All testing and inspecting specifically called for and/or described in this section of the specifications are referred to as Quality Assurance Services and are the responsibility of the Quality Assurance Agency. Except as hereinafter specified, Quality Assurance Services will be performed without expense to the Contractor. The Quality Assurance Agency is an independent testing and inspecting agency engaged by the Department through the Professional. Testing required because of changes in materials or proportions at the request of the Contractor shall be at the Contractor's expense. The Professional may engage more than one Quality Assurance Agency to perform services. Whenever the word "Contractor" is used it shall be interpreted to mean Prime Contractor or Contractors as applicable.
- B. Work Not Included: Quality Control Testing to be performed by the Contractor is specified in Section 014000.

**PART 2 – PRODUCTS (Not Used)**

**PART 3 – EXECUTION**

3.1 RESPONSIBILITIES AND DUTIES OF THE CONTRACTOR

- A. The use of Quality Assurance Services shall in no way relieve the Contractor of its responsibility to furnish materials and construction in full compliance with the plans and specifications or to perform Quality Control Testing where specified.
- B. To facilitate Quality Assurance Inspection or Testing, the Contractor shall:
  - 1. Secure and deliver to the project site, without cost, representative samples of materials it proposes to use and which are required to be tested under Paragraph 3.4, 'Tests and Inspections'.
  - 2. Furnish such casual labor as is necessary to obtain and handle samples at the project or at other sources of material.
  - 3. Provide means of safe access to work areas, provide conditions that allow testing and inspection to take place, provide materials for testing as requested, patch test sites when completed and furnish incidental labor and assistance necessary for inspectors of the Quality Assurance Agency to perform their tests and inspections.

3.2 AUTHORITY AND LIMITATIONS OF QUALITY ASSURANCE AGENCY

- A. Personnel representing the Quality Assurance Agency will not act as foremen nor perform other duties for the Contractor.
- B. Work will be checked as it progresses, but failure to detect any defective work or materials shall not in any way prevent later rejection when such defect is discovered, nor shall it obligate the Department or the Professional for final acceptance.

- C. The Quality Assurance Agency is not authorized to revoke, alter, relax, enlarge, or release any requirements of the specifications, nor to approve or accept any portion of the work.
- D. The Quality Assurance Agency shall report all test and inspection results to the Professional, the Department and the Contractor immediately after they are performed. Selection and frequency of tests shall be at the discretion of the Professional and the Department. All reports shall be uploaded to e-Builder within 24 hours of when the inspection occurs, test is conducted, test results obtained or similar service was conducted.
- E. Written reports of each inspection, test or similar service shall include but not be limited to:
  - 1. Date of issue.
  - 2. Project title and number.
  - 3. Name, address and telephone number of testing agency.
  - 4. Dates and location of samples and tests or inspections.
  - 5. Names of individuals making the inspection or test.
  - 6. Designation of the Work and test method.
  - 7. Identification of product and specification section.
  - 8. Complete inspection or test data.
  - 9. Test results and an interpretation of test results.
  - 10. Ambient conditions at the time of sample taking and testing.
  - 11. Comments or professional opinion as to whether inspected or tested work complies with Contract Document requirements.
  - 12. Name and signature of Quality Control Agency inspector.
- F. When it appears that any material furnished or work performed by the Contractor fails to fulfill contract requirements, the Quality Assurance Agency shall report such deficiency to the Professional, the Department and the Contractor.

### 3.3 CONTRACTOR'S FAILURE TO MEET CONTRACT REQUIREMENTS

- A. The Department and the Professional reserve the right to reject any items which do not meet the requirements of the plans and specifications and will require the contractor to replace these items and bear all expenses in connection with such replacements.
- B. The Contractor shall pay all costs incurred in providing additional testing and/or analysis (including engineering fees) required because of deficient test results or construction not in compliance with requirements of the Contract Documents.

### 3.4 TESTS AND INSPECTIONS

- A. Tests and inspections listed below may, at the discretion of the Professional and the Department, be performed by an independent Quality Assurance Agency engaged by the Department through the Professional, without expense to the Contractor. The Department reserves the right to change this list at any time.

**SECTION 1**

<b><u>REQ'D BY<sup>1</sup></u></b>	<b><u>DESCRIPTION OF TEST OR INSPECTION</u></b>	<b><u>REFERENCED STANDARD</u></b>	<b><u>IBC REFER-ENCE<sup>2</sup></u></b>
	<b>BITUMINOUS PAVING</b>		
DGS	Field inspection of construction procedures		
DGS	Bulk Specific Gravity...of Compacted Bituminous Mixtures...	ASTM D1188 or D 2726	
DGS	Density of Bituminous Concrete in Place by Nuclear Method	ASTM D 2950	
DGS	Thickness or Height of Compacted Bituminous Paving Mixture Specimens	ASTM D 3549	
	<b>EARTHWORK</b>		
	Perform compressive strength tests of grout		
	Perform slump tests on grout	AASHTO T119	
	Rigid Inclusions: monitor the load test CTA Pier and/or Rigid Inclusion installation and testing.		
	Rigid Inclusions: monitor the installation of CTA Piers and/or Rigid Inclusions to verify that the production installation practices are similar to those used during the installation of the modulus test elements.		
	<b>CONCRETE</b>		
IBC	1. Inspection of reinforcing steel and placement	ACI 318: Ch20. 25.2, 25.3, 26.6.1-26.6.3	1908.4
	2.		
	3.		
	4.		
IBC	5. Inspection of reinforcing steel welding, in accordance with Table 1704.3, Item 5b	AWS D1.4; ACI 318: 26.6.4	
IBC	6. Inspection of bolts to be installed in concrete prior to and during placement of concrete, where allowable loads have been increased or where strength design is used	ACI 318: 8.1.3, 21.2.8	
IBC	7. Inspection of anchors installed in hardened concrete	ACI 318: 17.8.2.4 ACI 318: 17.8.2	

<u>REQ'D BY<sup>1</sup></u>	<u>DESCRIPTION OF TEST OR INSPECTION</u>	<u>REFERENCED STANDARD</u>	<u>IBC REFER-ENCE<sup>2</sup></u>
IBC	8. Verifying use of required design mix	ACI 318: Ch. 19, 26.4.3, 26.4.4	1904.1, 1904.2, 1908.2, 1908.3
IBC	9. Prior to concrete placement, fabricate specimens for strength tests, perform slump and air content tests, determine the temperature of the concrete	ASTM C172, C31; ACI 318: 26.4, 26.12	
IBC	10. Inspection of concrete and shotcrete placement for proper application techniques	ACI 318: 26.5	1908.6, 1908.7, 1908.8
IBC	11. Verify for maintenance of specified curing temperature and techniques	ACI 318; 26.5.3-26.5.5	1908.9
DGS	Review Contractors' design mixes, Certificates of Compliance and material test reports		
DGS	Compressive Strength of Cylindrical Concrete Specimens <sup>2</sup>	ASTM C39	
	<b>CAST STONE</b>		
DGS	Absorption of Architectural Cast Stone	ASTM C1195	
	<b>MASONRY</b>		
DGS	Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry, Annex A7 Compressive Strength <sup>6</sup>	ASTM C780	
DGS	Method of Sampling and Testing Grout <sup>6</sup>	ASTM C1019	
	<b>Level 1 Special Inspection</b>		
IBC	1. Compliance with required inspection provisions of the construction documents and the approved submittals shall be verified.	Art. 1.5 <sup>5</sup>	
IBC	2. Verification of $f'_m$ and $f'_{AAC}$ prior to construction except where specifically exempted by this code.	Art. 1.4B <sup>5</sup>	
IBC	3. Verification of slump flow and VSI as delivered to the site for self-consolidating grout.	Art. 1.5B.1.b.3 <sup>5</sup>	
IBC	4. As masonry construction begins, the following shall be verified to ensure compliance: a. Proportions of site-prepared mortar b. Construction of mortar joint c. Location of reinforcement connectors, prestressing tendons and anchorages d. Prestressing technique e. Grade and size of prestressing tendons and anchorages	Art 2.6A <sup>5</sup> Art 3.3B <sup>5</sup> Art 3.4, 3.6A <sup>5</sup>  Art 3.6B <sup>5</sup> Art 2.4B, 2.4H <sup>5</sup>	

<b>REQ'D BY<sup>1</sup></b>	<b>DESCRIPTION OF TEST OR INSPECTION</b>	<b>REFERENCED STANDARD</b>	<b>IBC REFER-ENCE<sup>2</sup></b>
IBC	5. The inspection program shall verify: <ol style="list-style-type: none"> <li>Size and location of structural elements</li> <li>Type, size and location of anchors, including other details of anchorage of masonry to structural members, frames or other construction.</li> <li>Specified size, grade and type of reinforcement, anchor bolts, prestressing tendons and anchorages.</li> <li>Welding of reinforcing bars</li> <li>Preparation, construction and protection of masonry during cold weather (temperature below 40°F) or hot weather (temperature above 90°F)</li> <li>Application and measurement of prestressing force</li> </ol>	Art 3.3F <sup>5</sup> Sec 1.2.2(e) <sup>4</sup> , 1.16.1 <sup>4</sup>  Sec 1.15 <sup>4</sup> , Art 2.4, 3.4 <sup>5</sup> Sec 2.1.9.7.2, 3.3.3.4(b) <sup>4</sup> Art 1.8C, 1.8D <sup>5</sup>  Art 3.6B <sup>5</sup>	Sec 2104.3, 2104.4
IBC	6. Prior to grouting, the following shall be verified to ensure compliance: <ol style="list-style-type: none"> <li>Grout space is clean</li> <li>Placement of reinforcement and connectors and prestressing tendons and anchorages</li> <li>Proportions of site-prepared grout and prestressing grout for bonded tendons</li> <li>Construction of mortar joints</li> </ol>	Art 3.2D <sup>5</sup> Sec 1.13 <sup>4</sup> , Art 3.4 <sup>5</sup>  Art 2.6B <sup>5</sup>  Art 3.3B <sup>5</sup>	
IBC	7. Grout placement shall be verified to ensure compliance with code and construction document provisions <ol style="list-style-type: none"> <li>Grouting of prestressing bonded tendons</li> </ol>	Art 3.5 <sup>5</sup>  Art 3.6C <sup>5</sup>	
IBC	8. Preparation of any required grout specimens, mortar specimens and/or prisms shall be observed	Art 1.4 <sup>5</sup>	Sec 2105.2.2, 2105.3
<b>STEEL CONSTRUCTION</b>			
IBC	1. Material verification of high-strength bolts, nuts, and washers: <ol style="list-style-type: none"> <li>Identification markings to conform to ASTM standards spec in the approved CDs.</li> <li>Manufacturer's Certificate of Compliance required</li> </ol>	AISC 360, Section A3.3 and applicable ASTM material standards	
IBC	2. Inspection of high-strength bolting: <ol style="list-style-type: none"> <li>Snug-tight joints</li> <li>Pretensioned and slip-critical joints using turn-of-nut with matchmarking, twist-off bolt or direct tension indicator methods of installation.</li> <li>Pretensioned and slip-critical joints using turn-of-nut without matchmarking or calibrated wrench methods of installation (N/A; DGS requires twist-off bolt or direct tension indicator)</li> </ol>	AISC 360, Section M2.5	1704.3.3
IBC	3. Material verification of structural steel and cold-formed steel deck: <ol style="list-style-type: none"> <li>For structural steel, identification markings to conform to AISC 360</li> <li>For other steel, identification markings to conform to ASTM standards specified in the approved CDs</li> <li>Manufacturer certified test reports</li> </ol>	AISC 360, Section M5.5 Applicable ASTM material standards	

<b>REQ'D BY<sup>1</sup></b>	<b>DESCRIPTION OF TEST OR INSPECTION</b>	<b>REFERENCED STANDARD</b>	<b>IBC REFER-ENCE<sup>2</sup></b>
IBC	4. Material verification of weld filler materials: a. Identification markings to conform to AWS specification in the approved CDs b. Manufacturer's Certificate of Compliance required	AISC 360, Sect A3.5 and applicable AWS A5 documents	
IBC	5. Inspection of welding: a. Structural steel 1) Complete and partial penetration groove welds 2) Multi-Pass fillet welds 3) Single-pass fillet welds > 5/16" 4) Plug and slot welds 5) Single-pass fillet welds < 5/16" 6) Floor and deck welds b. Reinforcing steel: 1) Verification of weldability of reinforcing steel other than ASTM A 706 2) Reinforcing steel-resisting flexural and axial forces in intermediate and special moment frames, and boundary elements of special reinforced concrete shear walls, and shear reinforcement 3) Shear reinforcement 4) Other reinforcing steel	AWS D1.1  AWS D1.3  AWS D1.4 ACI 318: Section 3.5.2	1704.3.1           1704.3.1
IBC	6. Inspection of steel frame joint details for compliance with approved CDs: a. Details such as bracing and stiffening b. Member locations c. Application of joint details at each connection		1704.3.2
DGS	Liquid Penetrant Examination	ASTM E165	
DGS	Guide for Magnetic Particle Examination	ASTM E709	
DGS	Practice for Ultrasonic Contact Examination of Weldments	ASTM E164	
DGS	Guide for Radiographic Examination	ASTM E94	
<b>OPEN-WEB STEEL JOISTS AND JOIST GIRDERS</b>			
IBC	Installation of open-web steel joists and joist girders	SJI 2207.1	1705.2.3
IBC	Visually inspect installation of bridging	SJI 2207.1	1705.2.3
<b>STEEL DECKING</b>			
IBC	Verify Compliance of materials including profiles, material properties, type/grade, and base metal thickness	SDI QA/QC	1705.2.2
IBC	Verify size and location of welds, including support, sidelap, and perimeter welds	SDI QA/QC	1705.2.2
IBC	Verify welds meet visual acceptance criteria	SDI QA/QC	1705.2.2
IBC	Verify manufacturer installation instructions for mechanical fasteners	SDI QA/QC	1705.2.2



<u>REQ'D BY<sup>1</sup></u>	<u>DESCRIPTION OF TEST OR INSPECTION</u>	<u>REFERENCED STANDARD</u>	<u>IBC REFER-ENCE<sup>2</sup></u>
IBC	Verify mechanical fastener spacing and type	SDI QA/QC	1705.2.2
IBC	Verify type and installation of support fasteners, type and installation of sidalap fasteners, and type and installation of perimeter fasteners	SDI QA/QC	1705.2.2
	<b>SPRAYED FIRE-RESISTANT MATERIALS</b>		
IBC C	Professional to determine requirements. Professional to determine requirements.	ASTM E 119	
	<b>GENERAL OVERVIEW OF QC TESTING</b>		
DGS	Review of Contractor QC Testing and Reports		

**SECTION 2**

<u>REQD BY<sup>1</sup></u>	<u>DESCRIPTION OF TEST OR INSPECTION</u>	<u>REFERENCED STANDARD</u>	<u>IBC REFER-ENCE<sup>2</sup></u>
	<b>SOILS</b>		
IBC	1. Verify materials below shallow foundations are adequate to achieve the design bearing capacity		1705.6
IBC	2. Verify excavations are extended to proper depth and have reached proper material		1705.6
IBC	3a. Perform testing of compacted fill materials	ASTM D6938	1705.6
	3b. Perform classification of proposed compacted fill		1705.6
	3c. Perform Modified Proctor testing of proposed compacted fill	ASTM D1557	1705.6
	3d. Perform Standard Proctor testing of proposed compacted fill	ASTM D698	
IBC	4. Verify use of proper materials, densities and lift thicknesses during placement and compaction of compacted fill		1705.6

IBC	5. Prior to placement of compacted fill, observe subgrade and verify that site has been prepared properly		1705.6
IBC	6. Verify ground improvement element aggregate properties, number of lifts of aggregate, element size and depth		1705
	<b>ENGINEERING SERVICES</b>		
DGS	Review of Contractor QC Test Reports.		
DGS	Review of Contractor QC Soil Bearing Test Reports.		
DGS	On-site Engineering Consultation <sup>7</sup>		
DGS	Office Engineering Consultation <sup>7</sup>		

Footnotes:

1. "DGS" are tests required by DGS and "IBC" are test required by Chapter 17 of the 2015 International Building Code.
2. IBC 2015.
3. Not used.
4. Refers to reference ACI 530/ASCE 5/TMS 402.
5. Refers to reference ACI 530.1/ASCE 6/TMS 602.
6. Concrete, mortar or grout molds are to be made by QA Agent under Special Inspection hours.
7. Principal(s) shall be Registered Professional Engineer(s). The Engineer making decisions and recommendations shall be a Registered Pennsylvania Professional Engineer.

**END OF SECTION**

**SECTION 01 50 00**  
**TEMPORARY UTILITIES**

**PART 1 – GENERAL**

1.1 STIPULATIONS

- A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 - General Requirements” form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 TEMPORARY SERVICES DURING CONSTRUCTION

- A. The designated Contractor shall install, operate, protect and maintain the temporary services, as hereinafter specified, during the construction of the entire Project.
- B. Temporary connections to new and/or existing permanent service lines shall be made at the appropriate locations as determined by the designated Contractor, and coordinated with the Department, in conjunction with the Client Agency (as applicable). When the temporary service lines are no longer required, they shall be removed by the Contractor. Any part or parts of the permanent service lines, grounds and building, disturbed and damaged by the installation and/or removal of the temporary service lines, shall be restored to their original condition by the Contractor responsible for the temporary installation.
- C. If the Contractor fails to carry out its responsibility in supplying temporary services as set forth in this Contract, it is responsible for such failure, and the Department may take such action as it deems proper for the protection and conduct of the work, and shall deduct the cost involved from the amount due the Contractor. Only those temporary utilities required for construction need to be extended to the work area(s).
- D. Temporary utilities for Prime Contractors’ office trailers shall be arranged and paid for by each responsible Prime Contractor. The Lead Contractor shall arrange, provide, install, and pay for all temporary utilities required for the DGS Construction Project Manager’s office/ trailer.

1.3 TEMPORARY WATER SUPPLY

- A. The Plumbing Contractor shall install, operate, protect, and maintain an adequate water supply during the period of construction, either by means of the permanent water supply line, or by the installation of a temporary water supply. The temporary water supply shall be in place within fifteen (15) days of any Prime Contractor’s written request for such services.
  - 1. HVH will allow the plumbing contractor to connect to an existing hydrant on site to access the water supply.
- B. The Plumbing Contractor will be required to bring the temporary water supply to a point approximately ten (10) feet from the work area(s) and to provide a meter and RPZ back-flow preventer.

1.4 TEMPORARY HEAT

- A. The temporary heat requirements on this Project are divided into two (2) categories: (1) temporary heat required prior to the enclosure of the building, buildings, or portions thereof; and (2) temporary heat required subsequent to the enclosure of the building, buildings or portions thereof.
- B. A building or portion thereof shall be considered to be enclosed when (a) the roof is on and tight; (b) the exterior walls have been completed; and (c) when openings, doors and windows

are closed with permanent closures, or with substantial temporary closures which will affect the retention of heat within the building or portion thereof.

- C. Prior to enclosure of building, buildings or portions thereof, and when official local weather predictions indicate below freezing temperatures or temperatures that may damage the work, each Contractor shall provide, maintain, operate and pay all costs, including fuel, for a sufficient number of approved portable heaters, so that the progress of its work is not impeded, and proper protection of its work from freezing is maintained. Self-contained oil/gas/propane-fired portable heaters, if used, must be vented to the outside of the enclosed structure. Unvented fuel-fired portable heaters may be used only when the building is not enclosed.
- D. After the building, buildings or portions thereof are enclosed, and temporary heat is required for proper construction, the HVAC Contractor, at its own cost and expense, shall provide equipment and heating personnel for the temporary heat. The HVAC Contractor may, with the Department's and Client Agency's approval, utilize the permanent system or portions thereof, or may install temporary steam or hot water radiation or convectors or a combination of both. The HVAC Contractor shall operate portable steam or hot water generating equipment for supply to permanent or temporary building heating facilities.
- E. Temporary heating system, as hereinafter noted, shall be of sufficient capacity to heat the interior of the building to 60°F when outside temperature is 0°F. The interior temperature must be 60°F or above at all times. This service shall be continued until the entire Project is completed, except as hereinafter noted.
- F. Where electricians or plumbers are required to install, operate supervise or maintain equipment used in the provisions of temporary heat, the payment of the services of such material and personnel shall be the responsibility of the Electrical and the Plumbing Contractors respectively. It will be the responsibility of the Electrical and Plumbing Contractors to coordinate with the HVAC Contractor for temporary heat.
- G. The Lead Contractor shall pay for all fuel and electricity for the temporary heat in conjunction with the operation of heating equipment for enclosed buildings, or enclosed portions thereof, unless provided by the Client Agency as noted above.
- H. The Lead Contractor shall remove normal soot, smudges, and other deposits from walls, ceilings and exposed surfaces which are the result of the use of any temporary heating equipment after enclosure, including the use of the permanent heating system for temporary heating purposes. Finish work shall not start until all such surfaces are properly cleaned. Soot, etc. caused by equipment malfunction shall be removed by the responsible Contractor. Each Prime Contractor shall correct/replace any of their respective work that is identified by the Department or Professional as not meeting the project specifications as a result of the failure of any Prime Contractor to maintain or provide appropriate temporary heat, cooling, dehumidification, or ventilation in accordance with the contract requirements or the manufactures requirements. Each Prime Contractor will follow the requirements of the General Conditions regarding any disputes due to another Prime Contractor's failure to provide or maintain proper temporary heating, cooling, dehumidification, or ventilation of the conditioned space. Each Prime Contractor shall correct/replace any of their respective work that does not meet Contract requirements due to use of temporary heat.
- I. All permanent heating equipment used to supply temporary heat shall be completely cleaned and reconditioned by the HVAC Contractor, in the presence of the Department personnel, prior to Final Acceptance. Cleaning of permanent HVAC ducts utilized for temporary heat shall be required. The HVAC Contractor should filter the return air at grilles, and wherever necessary to prevent dust accumulation. All permanent heating equipment, such as radiator trap seats and diaphragms, valve sets and discs, strainer internals or any other equipment found to be damaged due to being used for temporary heat shall be replaced. All replacements must be inspected by the Professional and accepted by the Department personnel. The HVAC Contractor shall pay for all replacement parts and labor.

- J. The cost of temporary heat shall be made a part of the lump sum bid submitted by each Contractor, as applicable. The cost of temporary heat after enclosure shall be shown on the Contract Schedule of Values, to include the number of calendar days, cost per twenty-four (24) hour day and extended price. Any adjustment to the number of days of temporary heat, used or not used, may be based on this unit price. Each Contractor shall include **[xxx]** calendar days of temporary heat after building enclosure, in its bid.
- K. Temporary Ventilation and Temperature Control: The Lead Contractor shall provide electronic daily temperature/humidity readings equipment and log the conditions throughout the building to assure the proper and adequate temperature/humidity levels are recorded and maintained. The Lead Contractor shall provide the appropriate temporary ventilation, dehumidification, humidification or cooling equipment to assure the interior humidity/temperature levels are provided to meet all building finish requirements in accordance with the manufacture requirements.

#### 1.5 CONSTRUCTION LIGHT AND POWER

- A. The Electrical Contractor shall install, operate, protect and maintain the temporary service for construction light and power. The Contractor shall extend the temporary wiring throughout the project work areas, properly insulated and installed in accordance with Article 300 of the National Electrical Code. All wiring shall be installed by a licensed electrician.
- B. The Electrical Contractor shall furnish this service within fifteen (15) days of any Prime Contractor's written request for such services. The service shall be sized to satisfy project requirements, but shall not be less than 200 amp, single-phase, 3-wire 120/240 volts, with fused safety switch protection required. Additional capacity in the form of other independent services and panels shall be provided as needed at required location throughout the site to meet the requirements of this section.
- C. The Electrical Contractor shall extend electrical wiring into the building to provide adequate light and power, for the proper execution of the work. The Electrical Contractor shall also provide three-phase, 208 volt power service, if required. As construction progresses, it shall extend the temporary services to all areas where required, with a minimum of 100W incandescent equivalent light and duplex power outlets at 20 feet on center minimum, and at least in every room or space. The maximum size motor to be used at any power service shall be limited to 5 hp. Construction light and power provided shall fully comply with all provisions for this service of the National Electric Code and OSHA.
- D. Where a service of a type other than that as herein mentioned is required, each Contractor requiring same shall provide such service and necessary equipment at its own expense.
- E. The Electrical Contractor, prior to the installation of the permanent service, shall provide portable generators or shall extend a temporary service line to the site, and shall sign for the meter and pay all electrical connection costs.
- F. The Electrical Contractor shall provide all transformers necessary to provide temporary power.
- G. The Electrical Contractor shall provide all meters and/or submeters required and necessary to meter usage.
- H. The Lead Contractor shall pay all electric consumption and associated costs for its use and that of all Prime Contractors, until Closeout Inspection occurs, and all items of work are certified to be complete.

#### 1.6 WELDING

- A. Any Contractor using electrical power for welding on the site shall use self-contained engine generating units.

- B. Each Contractor shall provide necessary exhaust/ventilation/filtration to prevent accumulation of welding fumes and smoke generated by welding their operations.
- C. Each Contractor shall have all precautions and protection in place while welding to assure no sparks cause fire or smoke damage to all surrounding areas; during and after all welding activities.

#### 1.7 FIRE EXTINGUISHERS

- A. Each Contractor shall provide UL listed, NFPA approved fire extinguishers, ten (10) lb. minimum, at the construction site during operations, suitable for all types of fires in accordance with OSHA.

#### 1.8 INTERRUPTION OF SERVICES

- A. Each Prime Contractor shall have all needed equipment and material to complete planned work at the site, prior to shutting down any system.
- B. No additional compensation or time will be given to the Contractor, if work must be performed on State or National Holidays or on weekends or on overtime. See paragraph on 'Working Hours' under Section 010400.
- C. Contractors are to follow all requirements stated in Articles 6.21 and 6.22 of the General Conditions and submit the "Utility Shutdown Checklist" form accessed through the e-Builder Forms Module for approvals. Forms are located under the Project Menu along the left column of e-Builder. The "Utility Shutdown Checklist" form is listed under Workflow Forms within the "All Workflow and Static Forms" drop-down menu.

#### 1.9 SNOW/ICE REMOVAL

- A. The Lead Contractor shall be responsible to provide snow removal and anti-skid material into to site and at the project site and indicated laydown areas (including construction trailer), unless directed otherwise.
- B. All related work shall be performed to provide proper and safe access throughout the site subsequent to each related work day. Any delay and potential related costs generated by failure to meet this requirement shall be the responsibility of the Lead Contractor.

#### 1.10 DEWATERING

- A. Each Prime Contractor shall provide adequate attention, equipment and manpower to the project to assure the work area is dewatered as required to eliminate ponding, excessive water, depressions, etc. as affected by and for their work activities. Such action shall occur no later than 24 hours after a rain or water producing event. This effort shall be sustained for the time period necessary to bring the affected area back into conformance.

#### 1.11 HOISTING FACILITIES

- A. Each Prime Contractor must provide hoisting facilities for its own work. All hoisting facilities must comply with the safety regulations of the Department of Labor and Industry.

### **PART 2 - PRODUCTS (Not Used)**

### **PART 3 - EXECUTION (Not Used)**

**END OF SECTION**

## SECTION 01 56 39

### TEMPORARY TREE PROTECTION

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions" and "Division 1 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section includes general protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.

##### 1.3 DEFINITIONS

- A. Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Tree Pruning Schedule: Written schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction.

##### 1.5 INFORMATIONAL SUBMITTALS

- A. Certification: From arborist, certifying that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.
- B. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.
- C. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.

##### 1.6 QUALITY ASSURANCE

- A. Arborist Qualifications: Certified Arborist as certified by ISA, licensed arborist in jurisdiction where Project is located, current member of ASCA, or registered Consulting Arborist as designated by ASCA.
- B. Preinstallation Conference:



1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors
2. Conduct conference at Project site.

#### 1.7 PROJECT CONDITIONS

- A. Coordinate tree protection fencing with construction security fencing.
- B. The following practices are prohibited within protection zones:
  1. Storage of construction materials, debris, or excavated material.
  2. Parking vehicles or equipment.
  3. Foot traffic.
  4. Erection of sheds or structures.
  5. Impoundment of water.
  6. Excavation or other digging unless otherwise indicated.
  7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- C. Do not direct vehicle or equipment exhaust toward protection zones.
- D. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

### **PART 2 - PRODUCTS**

#### 2.1 MATERIALS

- A. Topsoil: Natural or cultivated top layer of the soil profile or manufactured topsoil; containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 1 inch in diameter; and free of weeds, roots, and toxic and other nonsoil materials.
- B. Organic Mulch: Shredded hardwood, free from deleterious materials.
- C. Tree Protection Fencing: Fencing fixed in position. Previously used materials may be used when approved by Architect.
  1. Chain-Link Protection-Zone Fencing: Galvanized-steel fencing
    - a. Height: 72 inches
- D. Protection-Zone Signage: Shop-fabricated, rigid plastic or metal sheet with attachment holes prepunched and reinforced; legibly printed with nonfading lettering.
- E. Root Aeration and Root Protection Matting

### **PART 3 - EXECUTION**

#### 3.1 EXAMINATION AND PREPARATION

- A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

- B. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.
- C. Protection Zones: Mulch areas inside protection zones and other areas indicated with 4-inch average thickness of organic mulch. Do not place mulch within 6 inches of tree trunks.

### 3.2 PROTECTION ZONES

- A. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones in a manner that will prevent people from easily entering protected area except by entrance gates.
  - 1. Mesh Fencing: Install per drawings
  - 2. Posts: Set or drive posts into ground one-third the total height of the fence without concrete footings. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to Architect.
  - 3. Access Gates: Install where indicated.
- B. Protection-Zone Signage: Install protection-zone signage in visibly prominent locations in a manner approved by Architect.
- C. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.
- D. Maintain protection-zone fencing and signage in good condition as acceptable to Architect and remove when construction operations are complete and equipment has been removed from the site.

### 3.3 EXCAVATION

- A. General: Excavate at edge of protection zones and for trenches indicated within protection zones according to requirements in Section 31 20 00 "Earth Moving."
- B. Trenching near Trees: Where utility trenches are required within protection zones, hand excavate under or around tree roots or tunnel under the roots by drilling, auger boring, or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning.
- C. Do not allow exposed roots to dry out before placing permanent backfill.

### 3.4 ROOT PRUNING

- A. Prune roots that are affected by temporary and permanent construction. Prune roots as shown on Drawings and as follows:
  - 1. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
  - 2. Temporarily support and protect roots from damage until they are permanently covered with soil.
  - 3. Cover exposed roots with burlap and water regularly.
  - 4. Backfill as soon as possible according to requirements in Section 31 20 00 "Earth Moving."

- B. Root Pruning at Edge of Protection Zone: Prune roots by cleanly cutting all roots to the depth of the required excavation.
- C. Root Pruning within Protection Zone: Clear and excavate by hand to the depth of the required excavation to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

### 3.5 CROWN PRUNING

- A. Prune branches that are affected by temporary and permanent construction. Prune branches as follows:
  - 1. Prune trees to remain to compensate for root loss caused by damaging or cutting root system. Provide subsequent maintenance during Contract period as recommended by arborist.
  - 2. Pruning Standards: Prune trees according to ANSI A300 (Part 1) and the following:
  - 3. Cut branches with sharp pruning instruments; do not break or chop.
  - 4. Do not apply pruning paint to wounds.
- B. Chip removed branches and stockpile in areas approved by Architect or dispose of off-site.

### 3.6 REGRADING

- A. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.
- B. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.
- C. Minor Fill within Protection Zone: Where existing grade is 2 inches or less below elevation of finish grade, fill with topsoil. Place topsoil in a single uncompacted layer and hand grade to required finish elevations.

### 3.7 FIELD QUALITY CONTROL

- A. Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.

### 3.8 REPAIR AND REPLACEMENT

- A. General: Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.
  - 1. Have arborist perform the root cutting, branch pruning, and damage repair of trees and shrubs.
  - 2. Treat damaged trunks, limbs, and roots according to arborist's written instructions.
  - 3. Perform repairs within 24 hours.
  - 4. Replace vegetation that cannot be repaired and restored to full-growth status, as determined by Architect.

3.9 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove excess excavated material, displaced trees, trash and debris, and legally dispose of them off Owner's property.

**END OF SECTION 01 56 39**

## SECTION 01 63 50

### DEPARTMENT OF MILITARY & VETERANS AFFAIRS (BVH) – SUPPLEMENTAL PROVISIONS

#### PART 1 – GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 - General Requirements” form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 PERSONAL BEHAVIOR

- A. Contractors are responsible for informing their employees of the special restrictions on personal behavior and the procedures/potential penalties for violations.
- B. Identification tags or badges to be furnished by the Institution Manager must be worn at all times while on facility property.
- C. Smoking is not permitted in any facility building.

##### 1.3 WORKING HOURS

- A. Refer to Specification Section 010400 – Coordination and Control for working hours. Any extension outside of these hours must be accomplished in accordance with the General Conditions and with the consent of both the Department and Institution Manager.

##### 1.4 VEHICLES

- A. Construction vehicles, as well as employees’ vehicles, will be parked in an area designated by Institution and Department and locked at all times. If any vehicles are to be left overnight, the license number or numbers of vehicles must be reported to the Institution Manager on a daily basis.

##### 1.5 TOOLS

- A. Tools shall be kept in a secure (locked) area when not in use and inventoried on a daily basis to ensure complete and total accountability. While the tools are being used, they shall be kept in view or on person. Broken or non-usable tools are to be disposed of away from Institutional property.

##### 1.6 FRATERNIZATION

- A. There shall be no fraternization or private relationships of Contractors' employees with residents and Institution Staff. This includes, but is not limited to, trading, bartering or receiving gifts, money, favors from the residents, or the residents’ friends, relatives or representatives.

##### 1.7 ALCOHOL AND CONTROLLED SUBSTANCES

- A. Alcoholic beverages and controlled substances shall not be carried, stored or consumed on Institutional property nor left in any vehicle.

##### 1.8 ORIENTATION PROGRAM

- A. The Institution agrees to provide an orientation program for covering security rules and regulations for the Contractors' personnel, with respect to residents’ safety and elopements.

- B. The contractor's personnel must attend a security orientation program prior to commencement of on-site work. No personnel of the contractor will be permitted to begin work on Institutional grounds without first attending the security orientation program. The contractor must schedule the orientation with the Institution, and budget his time accordingly. The Institution requires at least 10 days' notice for this activity and it will need to be a day that fits the Institution's schedule.
- C. Any contractor and their personnel exhibiting signs of illness that could be contagious to the residents must notify the Medical Director and Director of Nursing at the facility and follow their clinical recommendations including, but not limited to wearing a mask, avoidance of entry, etc.

#### 1.9 SECURITY CLEARANCE CHECK

- A. The Prime Contractor must obtain a criminal record check for all of its employees as well as the employees of Subcontractors or suppliers who will be required to enter the building as part of this project.
- B. The criminal record check must be requested from the Pennsylvania State Police by completing a 'REQUEST FOR CRIMINAL RECORD CHECK' FORM and submitting it to the Pennsylvania State Police.
- C. All Prime Contractors are responsible for the costs incurred with the record check including the processing fee for all of their employees as well as the employees of Subcontractors or suppliers who will be required to enter the building as part of this project.
- D. If a Contractor has not been a resident of the Commonwealth of Pennsylvania for the entire two-years (without interruption) immediately preceding the date of application for employment or currently lives out-of-state, in addition to the Pennsylvania State Police Criminal History Record Check, the Contractor will also need to obtain a Department of Aging FBI Criminal History Record Check. For more information, please visit [www.pa.cogentid.com](http://www.pa.cogentid.com).
- E. If the Criminal Record Check discloses a criminal record for a Contractor, Subcontractor or supplier employee, the Contractor shall not allow the employee access to the building, unless authorized by the Department.

#### **PART 2 – PRODUCTS (Not Applicable)**

#### **PART 3 – EXECUTION (Not Applicable)**

**END OF SECTION**

**SECTION 01 70 00**  
**COMMONWEALTH OF PENNSYLVANIA – COVID-19 PROVISIONS**

**PART 1 – GENERAL**

1.1 STIPULATIONS

- A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 - General Requirements” form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 ZERO TOLERANCE

- A. DGS Public Works has a zero tolerance for a Prime Contractor’s non-compliance with the Governor’s Office Guidance and this Supplemental Guidance for DGS Public Works Projects, collectively “DGS Guidance”.
- B. An authorized representative from each prime contractor will be required to acknowledge reading and understanding the DGS Guidance before anyone in that firm or their subcontractor, vendors or consultants can physically access the site.
- C. Any issue of creditable report regarding non-compliance with the guidance shall be a basis for the suspension of work. The Prime Contractor will be required to submit a corrective action plan detailing each issue of non-conformance and a plan to rectify the issue(s). The contractor will not be allowed to resume work until the plan is submitted to DGS.

1.3 PANDEMIC SAFETY OFFICER

- A. Each Prime Contractor shall provide the DGS Assistant Project Coordinator assigned to the project the name of their designated site-specific Pandemic Safety Officer (who may also be the Safety Officer).
- B. The Pandemic Safety Officer shall be responsible for observing employees and using best efforts to ensure their employees and all their subcontractors and suppliers comply with this DGS Guidance. At the start of each shift, the Pandemic Safety Officer must confirm that all employees reporting to the site are healthy and not experiencing any symptoms below.

COVID-19 Typical Symptoms:

- 1. Fever
  - 2. Cough
  - 3. Sore Throat
  - 4. Shortness of Breath
  - 5. Early symptoms such as chills, body aches, headache, diarrhea, nausea/vomiting and runny nose.
- D. If any employee exhibits any of the identified symptoms, the Pandemic Safety Officer must act in accordance with the Prime Contractor’s Amended Site Safety Plan, which should include removing an observed sick employee from the project site immediately. As provided by law, the identity of the worker must be kept confidential.
  - E. Any employee who develops COVID-19 as confirmed by laboratory testing or diagnosis by a healthcare provider shall not return to the site until released from isolation by either the healthcare provider or a public health official.

1.4 AMENDED SITE SAFETY PLAN

- A. Pursuant to Article 10 of the General Conditions of the construction contract, each prime contractor will be responsible for implementing an Amended Site Safety Plan which includes the DGS Guidance for operating during the COVID-19 emergency.

- B. The Department's Bureau of Construction will not be responsible for enforcing compliance with the DGS Guidance or with the prime contractor's Amended Site Safety Plan; that responsibility remains with each prime contractor and their Pandemic Safety Officer.

#### 1.5 NOTIFICATION OF EXPOSURE

- A. Upon learning of an infection, the Pandemic Safety Officer must immediately provide written notification to the other Prime Contractors' designated Pandemic Safety Officer, the DGS Assistant Project Coordinator and the Client Agency's site representative, while maintaining patient confidentiality.
- B. Each Prime Contractor must comply with all OSHA requirements relating to COVID-19. As of April 24, 2020, OSHA has determined that confirmed cases of COVID-19 shall be considered an "illness" for purposes of the OSHA 300 Log and Form 301.
- C. DGS reserves the right to suspend the project if it receives credible written confirmation of a positive test for any person on the project site.
- D. DGS will issue each Prime Contractor an excusable, non-compensatory extension of time covering any suspension for a positive test.

#### 1.6 JOB SITE REQUIREMENTS

- A. Contractor and DGS job trailers are restricted to only authorized personnel.
- B. Each Prime Contractor shall develop cleaning and disinfecting procedures for their job trailer and equipment. The Lead Contractor shall follow their cleaning and disinfecting procedures for cleaning and decontamination of the DGS Field Office aligned to CDC guidelines. The procedures must cover all areas including trailers, gates, equipment, vehicles, etc. and shall be posted at all entry points to the site and throughout the project site.
- C. Each jobsite must have laminated COVID-19 safety guidelines and handwashing instructions.
- D. Provide hand wash stations at appropriate locations on the site such as building entrances, break areas, food truck areas, offices, trailers, and job site egress areas.
- E. All restroom facilities/porta-potties should be cleaned, and handwashing stations must be provided with soap, hand sanitizer and paper towels.
- F. All surfaces should be regularly cleaned, including surfaces, door handles, laptops, etc. All common areas and meeting areas are to be regularly cleaned and disinfected at least once a day.
- G. A "social distancing" policy shall be enforced. Individuals must implement social distancing by maintaining a minimum distance of 6 feet from other individuals unless specific work requires deviation.
  - a. No handshaking.
  - b. No visitors allowed on the job site.
  - c. Site deliveries must be properly coordinated with the Prime Contractor's Safety Plan. Where possible, delivery personnel should remain in their vehicles.
  - d. Conduct all meetings via conference calls or web meeting sites if possible. Do not convene meetings of more than 10 people. Individual work crew meetings should be held outside and follow social distancing.
  - e. Endeavor to keep all crews a minimum of 6 feet apart at all times to eliminate the potential of cross contamination.
  - f. Stagger shifts, breaks, work areas and/or stacking of trades where feasible to minimize workers on site.
  - g. Limit tool sharing and sanitize tools if they must be shared.
  - h. In work conditions where required social distancing is impossible to achieve, affected employees shall be supplied PPE, including as appropriate a standard face mask and eye protection.



1.6 LIMITATIONS ON PERSONNEL

- A. Enclosed projects or portions of enclosed projects may not permit more than four persons on job sites of 2,000 square feet or less.
- B. One additional person is allowed for each additional 500 square feet of enclosed area over 2,000 square feet. These numbers are inclusive of employees of both prime and subcontractors, but not inclusive of delivery persons, code inspectors, or similar persons who require temporary access to the site and are not directly engaged in the construction activity. Enclosed square footage shall include all areas under roof that are under active construction at the time.

1.7 CLIENT AGENCY SPECIFIC REQUIREMENTS – DEPARTMENT OF CORRECTIONS

- A. Each contractor's employee(s) will be required to have their temperature taken with an infrared thermometer at the beginning of their shift. If the contractor's employee has a fever of 100.0 or higher or exhibits signs of coughing or shortness of breath, they will not be permitted entry to DOC property.
- B. Any contractor employee that is tested and found to be positive for COVID-19 shall not be permitted to return to the facility for minimum of 14 days, or 10 days and after 2 consecutive negative tests at least 24 hours apart.
- C. If an employee does not have a fever but exhibits signs of coughing or shortness of breath or is in close contact with a person who is under investigation for COVID-19, that employee will be denied entry to the institution.
- D. Infrared or digital thermometers will be used in conjunction with a questionnaire prior to entrance to the job site on Commonwealth property.
- E. The contractor is strongly encouraged to conduct employee tracking to further identify possible spread of COVID-19.

**PART 2 –PRODUCTS (Not Used)**

**PART 3 –EXECUTION (Not Used)**

**END OF SECTION**

DEPARTMENT OF GENERAL SERVICES  
ACKNOWLEDGEMENT OF DGS GUIDANCE ON COVID-19

As of the date noted below, I am an authorized representative of the Prime Contractor and acknowledge that I have read and understand the DGS Guidance. My company will utilize best efforts to comply with the DGS Guidance and any Client Agency guidance that may be site-specific.

Prime Contractor Company Name:

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Prime Contractor's Authorized Representative:

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Representative's Signature:

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Date: \_\_\_\_\_

SECTION 019113  
GENERAL COMMISSIONING REQUIREMENT

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

- A. The systems installed under Divisions 01, 22, 23, and 26, as well as pieces of equipment provided under other Divisions that connect to or interface with the systems of Divisions 01, 22, 23, and 26 will be evaluated, started, and tested (commissioned) to ensure that each performs per the intent of the design and/or representations made relative to performance, efficiency, and suitability for application in this project.
- B. Owner will employ an independent Commissioning Agent. The Commissioning Agent is an independent and knowledgeable third party, hired to verify that the systems work as per the design intent and provide the requirements of the commissioning responsibilities as designated in this specification. The Commissioning Agent will inform the Owner of the results of the commissioning, and provide suggestions, as necessary, to correct deficiencies in observed performance or installation.

1.4 COMMISSIONING OBJECTIVES

- A. Commissioning is intended to achieve the following specific objectives:
  - 1. The Owner will ultimately inherit a building that is designed to meet the needs of the user and is built and functions as designed.
  - 2. Systems performance expectations are clearly established.
  - 3. The users, project managers, operating personnel, contractors and designers will be protected from any dislocation created by the fragmented corrections and undocumented deficiencies.
  - 4. Corrective actions will be made in a manner that will not compromise long-term utilization or operating expense.
  - 5. The Owner's operating personnel will have the integrated system training needed to confidently operate and maintain the systems.
- B. The Commissioning Agent will be employed directly by the Owner to perform commissioning duties. Sections 019115, 230800, and 260800 outline the specific commissioning responsibilities of each Contractor for that division, and also obligate the Construction Manager to coordinate and manage the commissioning responsibilities of those sub-contractors.
  - 1. This section of the specification describes the process for commissioning and defines the responsibilities of the construction team.

2. The commissioning process shall be applied to all equipment, components, and systems as listed in this section, including specific interfaces to and from equipment and systems provided under separate contracts.
3. Building Commissioning work is a joint team effort to ensure that all systems function together properly to meet the design intent, and to document system performance parameters for fine-tuning of control sequences and operations procedures. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, equipment start-up, control system calibration, testing and balancing, training, and performance testing. This section does not supersede other requirements of the specifications. It may, though, expand on some of them.
4. Complementary to the contractor's responsibility to commission the building systems, it should be noted that a commissioning agent will be involved. This commissioning agent will provide equipment-systems installation inspection and performance verification. These Owner's verifications will be a pre-requisite to final equipment and systems acceptance by the Owner as per design documents. It should be emphasized that this Owner's systems verification does not negate the contractor's obligations to fully commission the building systems or relieve them of any contractual obligations. The contractor's personnel shall be made available to execute all aspects of the Commissioning Process until the Owner and the Engineer of Record accept the final results. Commissioning Program tasks and meetings may be repeated until the Owner and the Engineer of Record are satisfied and will not be fixed as one time, one chance events for the contractor.
5. The commissioning agent will verify equipment-systems installation and performance after the contractor provides written notice that the building equipment and systems have been completed, tested, and are fully operational. Upon this notification, the commissioning agent will verify the installation and performance of the equipment and system(s). If corrections are required after the initial verification, the commissioning agent will provide one (1) additional installation and performance verification. Subsequent installation and performance verifications will be at the Contractor's expense. The Contractor is responsible for all systems and equipment until final acceptance by both the Engineer of Record and the Owner. All guarantees and warranties shall not begin until final acceptance by both the Engineer of Record and the Owner.

#### 1.5 CONSTRUCTION TEAM RESPONSIBILITIES

- A. Within four (4) weeks of the award of the contract, the Division 01, 22, 23, and 26 contractors shall submit the names of the Project Manager who will be the commissioning coordinator for this project, as well as the names, addresses, phone numbers and qualifications of subcontractors' representatives and factory trained manufacturers' representatives for all equipment and systems required to participate in the commissioning process as specified in this Section.
- B. Each Contractor, and all his sub-trades and suppliers, shall cooperate with the commissioning agent in carrying out the commissioning process. In this context, each Contractor shall:
  1. Provide equipment and systems start-up as specified.
  2. Operate equipment and systems as required for initial systems operations and for final functional performance tests as they are performed by the commissioning agent, including the on-site participation of approved factory trained manufacturer's representatives for equipment.
  3. Attend commissioning meetings, and attend to action items arising from them, as required to allow the commissioning process to proceed on schedule.

4. Provide instruction and demonstrations for the Owner's designated operating staff, in conjunction with the commissioning agent, in order to meet all specified training requirements in this regard.
  5. The Contractors shall make any and all necessary corrections to systems, equipment, O & M manuals, as built drawings, and procedures as necessary to meet the design intent, contract documents, or performance requirements if errors are discovered during the commissioning process.
  6. The contractors shall supply all necessary documentation, such as shop drawings, submittal data, maintenance manuals, etc. required for equipment and systems, to the commissioning agent for preparation of the commissioning plan, checklists, and functional performance plans.
  7. The contractors shall provide the required names, addresses and qualifications of all specified Manufacturer's Representatives to participate in the commissioning process prior to the initial commissioning meeting.
  8. Subsequent installation and performance verifications, made necessary due to required corrections after initial verification, shall be at the respective Contractor's expense.
- C. Each Contractor shall provide to the commissioning agent three (3) copies of the following items as soon as they become available:
1. Construction schedule, including sub-schedules and milestones for all major mechanical and electrical equipment. (i.e. chillers, motor control center, air handlers, generators, VAV boxes, etc.)
  2. Certified and approved start-up and testing reports for all subsystem equipment that comprise the System.
  3. Control schematics and sequences of operation for the total system and all subsystems.
  4. Records of required inspections for code compliance, and documentation of approved permits and licenses to operate components of the System.
  5. Operating data which shall include all necessary instructions to the Owner's operating staff in order to operate the system to specified performance standards.
  6. Maintenance data which shall include all necessary information required to maintain all equipment in continuous operation, such as the testing, balancing and adjusting report and the as-built drawings.
  7. Written notice that building equipment and systems have been completed, tested, and are fully operational.
  8. Checklist of all submitted contract deliverables such as; manuals, spare parts, training, documentation, etc.

## 1.6 COMMISSIONING TEAM MEMBERS

- A. The members of the commissioning team consist of the Commissioning Lead Agent (CA) and support staff, The Pennsylvania State University Managers and Maintenance & Operating staff, the design team (A/E) (particularly the mechanical / electrical engineer), Testing and Balancing Contractor (TAB), Primary trades and other installing subcontractors or suppliers of equipment (Subs).
1. Commissioning Agent
  2. The Pennsylvania State University Personnel
  3. Architectural and Engineering Design Team
  4. Construction Manager
  5. HVAC Contractor
  6. Plumbing Contractor
  7. Control's Contractor
  8. Testing and balancing Contractor

- 9. Electrical Contractor
- 10. Selected Equipment Manufacturers

#### 1.7 CONSTRUCTION MANAGER (CM) RESPONSIBILITY

- A. Cooperate with the Commissioning Agent personnel, provide access to work, and provide adequate time in the work for commissioning tasks.
- B. Include the cost for commissioning requirements of Construction Manager in the contract price.
- C. Ensure cooperation between the sub-contractors and the commissioning team
- D. Attend commissioning specific pre-construction, planning and testing meetings. Provide input into the master scheduling process with regard to the timing and duration of the commissioning activities.
- E. Work with the Owner and the CA to schedule each training session with the appropriate O&M personnel.
- F. Provide written documentation that the systems are complete and ready for functional testing verification.
- G. Correct all contractor related deficiencies identified during any stage of the commissioning process.
- H. Furnish copies of all shop drawings, manufacturers' literature, maintenance information, or other information as may be requested.
- I. Provide qualified personnel for assistance to complete the commissioning tests, including seasonal testing.
- J. Coordinate the trades as per the commissioning agents testing and pre-testing responsibilities.
- K. Provide training with the assistance of the Commissioning Agent as outlined in Divisions 01, 23, and 26.
- L. Provide to the Commissioning Agent all proprietary test equipment required by manufacturers to test their equipment.
- M. Provide casual labor and facilities:
  - 1. To provide access to work to be tested.
  - 2. For Commissioning Agent's exclusive use, for storage of instruments and drawings, and preparation of daily reports.
- N. The Construction Manager shall provide a qualified individual to function as the MEP Coordinator (if applicable) to coordinate the Commissioning Program with the Commissioning Authority for those systems included in Divisions 01, 22, 23, and 26.
- O. The CM shall execute the Commissioning Program, through organization of all meetings, tests, demonstrations, training events, and performance verifications described in the Contract Documents and approved Commissioning Program. Organizational

responsibilities include preparation of agendas, attendance lists, arrangements for facilities and timely notification to participants for each Commissioning event.

- P. The CM, MEP Coordinator and all Subcontractors shall review the plans and specifications with respect to the completeness in all areas relating to the Commissioning Program. This includes ensuring that there are adequate items included in the design to ensure the ability to properly test, balance, and adjust the systems and to document the performance of each piece of equipment and each system. Any items that are required for Commissioning but not shown shall be brought to the attention of the CA and Engineer of Record (ER) prior to submittal of shop drawings. Likewise, any items that are required for Commissioning but not installed shall be provided at no additional cost to the project as per design intent.
- Q. The CM shall schedule a Pre-Commissioning Coordination Meeting within 90 days of the award of the contract, at the site and at a time suitable to all parties. This Pre-Commissioning Meeting will be for the purpose of reviewing the complete Commissioning Program and establishing tentative schedules for Maintenance Orientation and inspections, O & M submittals, training sessions, system flushing and testing, job completion, system startup, and test, adjust and balance work.
- R. The CM and Cx Agent will review and approve all functional performance tests, results, and documentation required by the contract documents, for all equipment and systems, as performed by subcontractors, vendors, etc. Develop schedules for all testing, integrate testing into the master construction activity schedule, and fully coordinate all subcontractors testing as required.
- S. The CM and Cx Agent shall submit Systems Testing Documentation Forms, schedules, and other commissioning documentation using the shop drawing submittal process, for approval by the ER and owner six months prior to starting any testing required by Division 23, and 26. The Owner, ER and CA reserve the right to require changes in the personnel assigned at any time to maintain quality assurance within the Commissioning Program at no additional cost to the project.
- T. The CM and Cx Agent shall coordinate directly with each subcontractor on the project specific to their responsibilities and contractual obligations. All contractors shall provide qualified personnel for participation in systems tests, including seasonal testing required after the initial testing.
- U. The CM, MEP Coordinator and all Subcontractors shall provide technical expertise to oversee, direct, and implement the correction of deficiencies found during the commissioning process. Observe the start-up and initial testing of equipment by the Contractor and Subcontractors and then all final PHVAC, SHVAC, building automation, fire alarm, emergency power, life safety, etc. The Contractor's personnel shall be made available to execute all aspects of the Commissioning Program until the ER and Owner accepts the final results. Commissioning Program tasks and meetings may be repeated until the ER and CA are satisfied and will not be fixed as one-time, one-chance events for the Contractor.
- V. Note any inconsistencies or deficiencies in system operations and enforce system compliance or recommend to the ER modifications to system design which will improve system performance.
- W. The CM shall coordinate through the Owner, CA and ER testing participation. When performance tests, results, and forms of documentation required by the contract documents are completed by the MEP Coordinator (if applicable), the Owner, ER, and



CA shall be notified and are fully operational. After such time, the CA will conduct systems performance verification.

- X. In the event that a performance verification test by the CA fails, the cause of failure shall be determined by the CM and rectified as soon as possible, and then re-tested. If more than two performance verification tests of the same system(s) are required, the contractors shall be required to reimburse the CA for additional retests as directed by the CM.
- Y. The CM shall assemble all record drawings and all records of Code authority inspections and approvals. The CM and MEP Coordinator shall review operation and maintenance information and as-built drawings and obtain all documentation from tests and assemble a final submittal to the ER, Owner, and CA for approval. The CM shall document warranty start and dates.
- Z. The CM shall oversee and/or provide training for the systems specified in Divisions 22, 23, and 26.

#### 1.8 COMMISSIONING AGENT'S DUTIES

- A. The commissioning agent is contracted directly with the owner and operates as the Owner's representative on-site.
- B. The commissioning agent shall develop and submit a detailed commissioning plan that would include all system testing requirements including, prefunctional and functional testing sheets, responsibilities, O&M manual and training requirements and forms.
- C. The commissioning agent shall execute the Commissioning Program, through organization of all meetings, tests, demonstrations, performance verification as described within.
- D. The commissioning agent shall be responsible for developing Prefunctional and Functional test procedures for all equipment and systems. Test procedures shall be in accordance with the manufacturer's recommendations, and shall fully describe the system configurations and tests for each component and system. Each test procedures shall include; specific criteria to be tested for, measured test results verses design requirements, prefunctional test sheets, approved submittal and contractor required testing.
- E. The commissioning agent shall develop and maintain the commissioning schedule that shall be updated during each commissioning meeting. The commissioning schedule shall be a copy of the CM schedule.
- F. The commissioning agent shall review all shop drawings, coordination drawings and submittals for completeness, accuracy and operational accessibility for all major equipment scheduled to be commissioned. All deficiencies shall be documented and submitted to the engineer for review.
- G. The commissioning agent shall coordinate directly with the CM during the commissioning meetings (and the subcontractors) to develop the commissioning requirements and schedules. All contractors shall provide qualified personnel for participation in the system tests, including seasonal testing.
- H. The commissioning agent shall witness selected contractor required testing including; piping hydrostatic and duct leakage tests. The contractors shall be responsible for coordinating these tests with the commissioning agent.

- I. The commissioning agent shall review the record drawings and “as-built” documentation for clarity and accuracy. Any discrepancies identified during this review shall be documented and shall be returned for resubmission.
- J. The commissioning agent shall review all operational and maintenance manuals for pre-approval prior to submission to the Engineer. Any discrepancies identified during this review shall be documented and returned to the contractors for resubmission.
- K. The commissioning agent will perform regular construction installation inspections during the construction timetable and include any identified deficiencies in the regular commissioning meetings. These items shall be reviewed and discussed during the commissioning meeting.
- L. The commissioning agent shall participate in the TAB process and perform random sampling of air and water testing to ensure completeness of services.
- M. The commissioning agent shall conduct an independent point-to-point verification (sample) of the building’s automation system once the control’s contractor submits in writing that their point-to-point is complete.
- N. Cooperate with Architect and Contractor; provide qualified personnel when scheduled.
- O. Promptly notify Architect and Contractor of irregularities or deficiencies of work, which are observed during performance of services.
- P. To test all systems as defined in the Commissioning Plan and the written functional test procedures.
- Q. The commissioning agent shall work directly with the Owner and Commissioning Team to provide resolution of deficiencies and provide recommendations to the team.
- R. Commissioning Agent is not authorized to:
  - 1. Release, revoke, alter, or expand requirements of Contract Documents.
  - 2. Approve or accept any portion of work.
  - 3. Perform any duties of the Contractor.

## 1.9 SYSTEMS TO BE COMMISSIONED

- A. Refer to Sections 019115, 220800, 230800, and 260800 for specific systems to be commissioned

## PART 2 - COMMISSIONING PROTOCOLS

### 2.1 OVERVIEW SIGN-OFF SHEETS

- A. The commissioning agent shall develop an overview sign-off sheet for each system being commissioned. The following is a sample of the sign-off sheet required for commissioning each system. The commissioning agent shall review each scheduling requirement and all must be signed off prior to moving forward to the next step. Each step must be complete and signed off by the required parties prior to moving ahead (i.e. functional testing can not start until the pre-functional checklist and deficiencies resolution is complete).

**COMMISSIONING REQUIREMENTS**  
**Basic Outline of Sign-off Prior to Next Steps**

**1. INSTALLATION**

	<b>Signature</b>	<b>Date</b>	<b>BIC</b>
Electrical Completion	_____	_____	E
Mechanical Completion	_____	_____	M
Automatic Temperature Controls	_____	_____	M
Flushing and Cleaning	_____	_____	M
Hydrostatic Testing Requirements	_____	_____	M
Duct Leakage Testing Requirements	_____	_____	M
Controls Point-to-Point Verification	_____	_____	M

**II. SYSTEM DELIVERABLES**

Hydrostatic Test Reports	_____	_____	M
Flushing and Cleaning Documentation	_____	_____	M
Operation and Maintenance Manuals	_____	_____	All
Equipment Submittals/Performance Data	_____	_____	All
Electrical Test Forms	_____	_____	E
Pre-Installation Test Forms	_____	_____	M
Testing & Balancing Pre-Balancing Report	_____	_____	M
Point-to-Point Check-out Report	_____	_____	M
Correction of Deficiency Reports	_____	_____	OR

**III. PRE-FUNCTIONAL TESTING**

Equipment Start-up Sheet	_____	_____	M
CA Point-to-Point Verification	_____	_____	CA
CA Pre-Functional Testing Sign-off	_____	_____	CA
Final Balancing Report	_____	_____	M
Owners "Ready for Functional Testing"	_____	_____	OR

**IV. FUNCTIONAL TESTING**

Functional Test Plan	_____	_____	CA
Correction of Performance Deficiencies	_____	_____	CA
Functional Test Acceptance	_____	_____	CA

**V. TRAINING**

Training Plan	_____	_____	CA
Training Agenda	_____	_____	CA
Training Record	_____	_____	CA
Training of Staff	_____	_____	All

**2.2 PRE-FUNCTIONAL TEST SHEETS**

- A. Prefunctional checklists are important to ensure that the equipment and systems are installed and started up as per the design documents and the manufacturer's start-up

procedures. The commissioning agent develops the prefunctional test sheets for each system and component to be commissioned. The pre-functional test sheets and check-out by the commissioning agent does not relieve the contractors from their duties of verifying system installation and proper system start-up. The commissioning agent will share the test sheets with the contractors for their review (if necessary). Once pre-functional test sheets are signed-off by the commissioning agent, functional performance testing may proceed without unnecessary delays. Each piece of equipment receives full prefunctional checkout by the CA. In general, the prefunctional testing for a given system, must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.

- B. Prefunctional checklists (or Testing Abstracts) are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., oil levels OK, fan belt tension, labels affixed, gages in place, sensor calibration, etc.). However, some prefunctional checklist items entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three phase pump motor of a chiller system). The word prefunctional refers to before functional testing. Prefunctional checklists augment and are combined with the manufacturer's start-up checklist.

## 2.3 FUNCTIONAL PERFORMANCE VERIFICATION

- A. Functional Performance Verification (FPV) is the dynamic testing of systems (rather than just individual components) under full, part and seasonal requirements. Systems are tested under various loads and control sequences, such as low cooling and heating loads, component failures, unoccupied modes, fire alarm, etc. The systems are run through all the control sequences of operation and components are verified to be responding as the design intent and documents. Functional performance verification shall include; testing all sequences of operations, verification of system capacity, generating simulated signals to simulate sensor values, conducting simulated conditions to tests all loads and verify system performance during all conditions of operation and verifying design intent. In addition, each system shall be tested through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part and full load). Proper responses such as power failures, freeze conditions, low-oil pressures, equipment failures, etc. shall also be tested. The commissioning authority develops the functional test sheets and procedures in sequential written form, coordinates the testing, conducts the testing and documents the testing. Each contractor is required is supply personnel to assist during the functional performance testing where applicable.
  - B. No system, equipment or component thereof shall be tested until the contractor and the CM has certified, in writing, that the system, equipment and / or components are complete, have been tested, adjusted and balanced and are ready for validating and performance testing. Functional Performance Verification is scheduled by the commissioning agent after the pre-functional testing requirements are complete and signed-off by the CM and the CA. Functional Performance Verification will not be conducted until a written notice of completion by the CM confirming that the system is ready for FPV. The air balancing and water balancing must be complete and the controls must be debugged prior to the performance verification.
1. Deferred Testing. The contractor shall be available to assist in seasonal testing, tests delayed until weather or other conditions building construction is completed, required building occupancy or loading, or other conditions are suitable for the demonstration of equipment or system's performance, as specified. These deferred tests shall be conducted in the same manner as the seasonal tests as soon as possible. Deferred testing shall be executed, documented and deficiencies corrected as specified herein for functional performance testing. Any adjustments or corrections to the O&M manuals and

“As built” documents required by the results of the testing shall be made before the seasonal testing process is considered complete.

## 2.4 TESTING DOCUMENTATION, NON-CONFORMANCE AND APPROVALS

- A. The commissioning agent shall clearly list any outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the testing form or on an attached sheet. The testing form and any outstanding deficiencies shall be provided to the CM / Owner within two days of test completion. The CA shall review the contractor’s startup testing procedures and reports and shall submit either a non-compliance report or an approval form to the contractor. The CA shall work with the contractor and others as necessary, to correct and retest all cost deficiencies or uncompleted items. The contractor shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the CA as soon as outstanding items have been corrected and resubmit an updated start-up report with a Statement of Correction on the original non-compliance report. When all requirements are satisfactorily completed, the CA shall recommend approval of the startup and prefunctional testing of each system and schedule the functional testing of the equipment or system.
- B. As functional performance testing progresses and a deficiency is identified, the CA shall discuss the issue with the executing contractor and the commissioning team.
  - 1. When there is no dispute of the deficiency and the contractor accepts responsibility for correcting it, the CA shall document the deficiency and the contractor’s response and intentions and the testing shall proceed, if possible. Corrections of minor deficiencies identified may be made by the contractor during the functional performance testing, at the discretion of the CA. Every effort shall be made or expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the commissioning effort.
  - 2. When the identified deficiency is corrected, the contractor shall sign the statement of correction at the bottom of the non-compliance form, certifying that the equipment is ready to be retested, and return the form to the CM. The CM shall sign the form and submit to the CA. The CA shall schedule the retest of the equipment or system involved.
  - 3. If there is a dispute about an identified deficiency, the CA shall document the deficiency and the contractor’s response, and provide a copy to the contractor. Every attempt shall be made to resolve the dispute at the lowest management level possible. When the dispute resolution has been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and returns the form to the CA. The CA shall schedule the retest of the equipment or system involved. Final interpretive authority shall be the A/E. Final acceptance authority shall be the Owner.
- C. During the functional performance testing of multiple units of similar equipment, the CA shall test all of the equipment and components that are to be commissioned. If, under such a testing procedure, three or more, identical pieces of equipment (size along does not constitute difference) fail to perform to the requirements of the Contract Documents (mechanically or substantively) due to manufacturing defects not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the CA. In such case, the contractor shall provide the CA with the following:
  - 1. Within one week of notification from the CA, the contractor or manufacturer’s representative shall examine all other identical units making a record of the findings. The findings shall be provided to the CA within two weeks of the original notice.

2. Within two weeks of the original notification, the contractor shall provide the CA and the A/E a signed and dated, written explanation of the problem, cause of failures, etc. and proposed solution, including full equipment submittals for corrective or replacement equipment, if appropriate. The proposed solution shall not be for less than the specification requirements of the original installation.
3. When approved, two examples of the proposed solution shall be installed by the contractor and the CA shall schedule and conduct functional testing of the proposed solution. Upon completion of the functional testing of the proposed solution, the CA shall recommend the acceptance or disapproval of the proposed solution to the Owner.
4. Upon acceptance of the proposed solution by the Owner, the contractor shall replace or repair all identical items, at their expenses and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week of approval of the proposed solution.
5. Where 15% or more of a group of devices or components have failed, it shall be deemed that the entire group failed and will require retesting once the corrections have been made. The CM shall submit a letter to the CA that the corrections have been made by the contractor and system can be retested.

D. Cost of Retesting

1. The cost for CA and/or Owner personnel to conduct the retesting of a functional performance testing requirements necessitated because a specific prefunctional or startup test item, reported to have been successfully completed, but found to be incomplete or faulty, shall be the responsibility of the contractor.
2. For a deficiency identified during the functional testing, not related to any prefunctional checklist or start-up fault, the CA and Owner shall direct the retesting of the equipment once all deficiencies have been rectified. However, all costs for any subsequent retesting shall be the responsibility of the contractor.
3. Items left incomplete, which later cause deficiencies or delays during functional testing may result in back charges to the responsible party.

## 2.5 OPERATION AND MAINTENANCE MANUALS

- A. Each contractor shall submit operational and maintenance manuals to the commissioning, through the CM, prior to training. The CA reviews the O&M manuals, documentation and redline as-builts for systems that are commissioned to verify compliance with the Specifications. The CA provides written feedback on O&M manuals to the PM. Upon successful review of the corrections, the CA shall recommend approval and acceptance of these sections. The CA also reviews each equipment warranty and verifies that all requirements to keep the warranty valid are clearly stated. This work does not supersede the Architect and Engineers responsibilities according to their contract.
- B. The O&M manuals shall be project specific, include all wiring diagrams and interconnections between trades. O&M manuals must meet at minimum the required checklist before acceptance for each component:
  1. Must be in a three-ring binder, with table of contents and tabbed sections.
  2. Building name, project title, project number, contractor name and contractor project number must appear on both the front cover and the spine of the binder.
  3. Provide a copy of the valve tag schedule at the front of the O&M manual
  4. Except for minor equipment, provide complete nameplate information at the front of the O&M. Include all data: serial numbers as well as complete motor nameplate data of corresponding equipment.

5. Provide a sheet at the beginning of the O&M listing equipment and the local supplier (with address and phone number) of that specific equipment.
6. For all equipment with warranties in excess of one-year (example VSD's), include extended warranty information in the front of the binder.
7. All information must be project specific. Do not provide generic vendor O&M manuals that cover multiple model numbers of equipment. Edit vendor O&M manuals to reflect exact equipment supplied. Cross out extraneous information not applicable to the specific equipment provided. Highlight applicable information for each piece of equipment installed.
8. For each piece of equipment, provide complete data relative to the make/model number, size, capacity data, manufacturer name and address, accessories included, etc. (i.e., provide complete information that would allow ordering the exact piece of equipment supplied). To accomplish this, include portions of the approved submittal for the piece of the equipment submitted. Do not include extraneous submittal information that does not facilitate actually ordering that piece of equipment.
9. If a piece of equipment contains multiple sub-assemblies provided by different manufacturers, include make/model number, size, capacity data etc. to allow the ordering of the exact replacement. For example, for an air-handling unit, provide information on each coil, filter, damper, fan etc.
10. Job specific, as-built, wiring diagrams, piping diagrams, etc. must be supplied for all equipment. All external connections must be shown on these diagrams. Example #1: for VSD's, terminal strip numbers where external control signal is landed must be indicated. Example #2: A piece of equipment is supplied with controls that interface with the project DDC system. Wiring diagram must be project specific and indicate interface with the project DDC system.
11. For all pumps and fans, include performance curves, accessories and motor manufacturer information.
12. For all flow elements (pitot tubes, triple duty valves, circuit setters, etc.) provide all flow curves.
13. For all air-handling systems, include sound power data (normally this was included in the equipment submittal).
14. For all filters, clean and dirty filter drops must be provided.
15. For all electrical equipment sensor calibration and setup requirements must be detailed in the O&M manuals.
16. Provide a list of all manufacturers spare parts for major equipment installed.
17. Provide an approved copy of the air and water balancing reports in the O&M.
18. Provide an as-built copy of the project control drawings in the O&M, along with the installation and maintenance information on individual control components.
19. Provide a copy of the equipment vibration test report in the O&M.
20. For equipment requiring a factory start-up, a start-up report is required for the O&M.

## 2.6 TRAINING REQUIREMENTS

- A. Each contractor is responsible for the training requirements. The CA shall be responsible for overseeing and approving the content of training the Owner's personnel for the equipment being commissioned. The CA will provide supplemental training if required by the Owner. Owner training and orientation on equipment and systems provided by the Contractor is accomplished in three general steps.
  1. Training Plan. After reviewing the specifications, and after interviewing facility staff, the Owner and Commissioning Authority (CA) document all the equipment for which training or orientation will be provided and designate responsible parties. This document lists, among other things, the type and number of trainees, rigor of training desired by the Owner, the primary responsible subcontractor, the trainer's

company and columns for tracking training agendas. The Commissioning authority provides this form to the Contractor for reference.

2. Training Agendas. For each piece of equipment or system for which training is provided, the Owner and CA develop a Training and Orientation Agenda. This agenda includes information regarding the scope of training and the intended audience. The CA develops a plan for including in the training session contractors/trainers from different disciplines, when appropriate. For example, the controls contractor may be asked to provide brief training on controls in the same session with the mechanical training for equipment controlled by the building automation system.
  - a. The agenda is then submitted to the Contractor who has provided documentation describing the subjects covered duration of each subject and the methods that will be used in the training, along with the name and qualifications of the trainer(s). The trainer returns this form to the Contractor, who submits it to the Owner and CA. The Owner and CA review the agenda; make comments; approve it and then submit back to the Contractor. The Contractor provides the approved agenda to the trainer to use during the training. The trainer provides a copy of the agenda to each trainee.
3. Training Record. The CA documents each training session (duration and general subjects covered). The trainer signs for the session and obtains the signature of each trainee. The trainer checks off subjects covered on the Agenda. When the training is complete, the Contractor provides a copy of the training record, and the trainer's agenda to the Owner and CA. The Owner and CA review the training record and make final approval by signing it. The CA will, as appropriate, witness the training sessions.

## 2.7 SCHEDULING REQUIREMENTS

- A. The As-Built drawings shall be updated to date and reviewed with the Commissioning Agent for approval no more than 45-days after all material is installed and in place
- B. Testing and Start-ups schedules shall be kept up to date. Advise the Commissioning Agent and the Owner (in writing) with a minimum of 60 hours prior to commencement
- C. Notify the commissioning agent and the Owner with a minimum of 2-weeks prior to the commencement of the TAB work for both the air and the hydronic systems.
- D. Conduct a controls meeting as required in 230800.

END OF SECTION



019115  
BUILDING ENVELOPE COMMISSIONING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes requirements for non-structural commissioning of the building envelope, including, but not limited to the following:
1. Above-grade construction, including: exterior wall systems and assemblies, windows, doors, floors and roofing systems.
  2. Interface conditions (flashings, expansion joints, and sealant) between each of the materials, components and systems that comprise the above -grade building envelope.
- B. The materials, components, systems, and assemblies that comprise the above grade building envelope will be evaluated and tested as outlined in this Section, as well as in accordance with each of the technical Sections associated with the design and construction of the building envelope. The purpose of the Building Envelope Commissioning Program (BECP) shall be to provide a process for an independent, third-party verification that the installed performance of the building envelope meets or exceeds the minimum performance requirements set forth by the contract documents for this project.
- C. Unless otherwise agreed to in writing between the Owner and Contractor, the BECP will be managed by the Commissioning Agent retained by the Owner and will include, by reference, all requirements set forth by the field performance testing of the materials, components, systems and assemblies that comprise the building envelope. In that context, it should be understood by all parties to this project that:
1. Full and complete compliance with the building envelope performance requirements set forth by the Architect-of-Record in the Basis-of-Design (BOD) for this project will be required to achieve successful “commissioning” of the building envelope.
  2. The requirements of this Section shall in no way relieve the Owner, Contractor, Architect of-Record and other parties to this project of their respective contractual obligations to the Owner for meeting the specified performance levels in the design and construction of this project.
  3. The “commissioning” requirements of the Construction Manager and sub-contractor or trade responsible for the final detailing and construction of the building envelope are to assist the Commissioning Agent during field inspections and performance testing of the Building Envelope.
- D. The Commissioning Agent shall provide periodic written summaries (Reports) of the work in progress during the construction of the building envelope. These reports will include, but may not be limited to, photographs and sketches as required illustrating conditions observed in the field, especially deficiencies noted for further review and acceptance by the Architect-of-Record for the project. Any changes to the contract documents arising

out of the Building Envelope Commissioning Program must be submitted, reviewed, and accepted in writing, by the Architect-of-Record and Owner and submitted with a series of details/schematics and material specifications to the Contractor for pricing prior to implementation on the project.

## 1.2 RELATED SECTIONS

- A. Division 01 Section 9113 "General Commissioning Requirements" for general requirements for commissioning processes.
- B. Division 23 Section 0800 "HVAC Commissioning Requirements" for commissioning the HVAC system and integrated system components interfacing with the building envelope.

## PART 2 - RELATED WORK

### 2.1 CONSTRUCTION MANAGER'S RESPONSIBILITIES

- A. Cooperate with the Commissioning Agent, provide access to work, and provide adequate schedule for the work for commissioning tasks.
- B. Furnish copies of all shop drawings, manufacturer's literature, installation instructions, maintenance information, schedules, warranties or other information as requested.
- C. Provide qualified personnel for assistance to complete the commissioning tests, including seasonal testing and all required air and any applicable water leakage testing for elements of the building envelope.
- D. Submit a copy of the Construction Manager's project and site specific Quality Assurance program to be implemented for construction for review by the Architect of Record, the Owner and the Commissioning Agent.
- E. Participate and ensure all subcontractors utilized for work on this contract participate in meetings prior to beginning construction with the various members of the design and construction teams, including, but not limited to, the Owner, Architect of Record, Commissioning Agent, Design Engineer, LEED consultant, suppliers, and manufacturer technical representatives. The subcontractors that must attend this meeting include all subcontractors that will be involved in the construction of the building envelope, including, but not limited to, the roofing, wall system, flashing, sealant, fenestration, concrete, steel, HVAC, electrical, interior framing and drywall contractors. This meeting will be to discuss construction sequencing and the coordination of trades and the Construction Manager's project and site-specific Quality Assurance program to be implemented that will be completed during construction of the building envelope.
- F. Provide a representative to be present, and have a representative present from each trade and/or subcontractor associated with installing the system during random building envelope air and water leakage performance testing, as indicated within the individual sections within Divisions 2 through 9. Provide a written protocol and a timeline for repair of any deficiencies noted during the performance testing and/or a written report from the

third party agency performing the tests indicating what repairs were required. If a systemic problem is identified during testing, please see the following requirement.

- G. Provide a repair and remediation protocol for any systemic failures identified by the Commissioning Agent, including a timeline for repair of all affected elements. Repaired elements shall not be covered up without review and documentation by the Commissioning Agent.
- H. Participate in maintenance orientation and inspection and in one maintenance and training session with the building operations and maintenance staff and other participants identified by the Owner and Architect-of-Record, with the assistance of the Commissioning Agent.
- I. Provide labor and facilities to provide access to work to be tested and For Commissioning Agent's exclusive use, for storage of instruments and drawings, records, and preparation of daily reports.

## 2.2 PERFORMANCE REQUIREMENTS

- A. Reference the Basis of Design developed by the Architect-Of-Record.

## 2.3 SUBMITTALS

- A. The Contractor is to provide the following submittals to the Commissioning Agent in addition to submitting them to the Architect-of-Record. These submittals are in addition to those specified in Division 01 Section 9113 "General Commissioning Requirements."
  - 1. Coordination Drawings: Provide cross references on any and all shop drawings indicating that drawings have been checked and cross-referenced by the Contractor to ensure that adjacent elements (i.e. wall elements and fenestration elements) and the dimensions and construction tolerances indicated will allow all work at interfaces to be constructible.
  - 2. Qualifications Data: For fabricators, installers, and testing agencies, submit to the Commissioning Agent for review all qualifications required in Divisions 2 through 9 for review.
  - 3. Special Inspections Reports for all special inspections indicated by the Architect/Engineer-of-Record in the specifications.

## 2.4 SYSTEMS TO BE COMMISSIONED

- A. The following are systems to be commissioned.
  - 1. Building Shell
  - 2. Exterior Wall Assemblies
  - 3. Roof Assemblies
  - 4.

## PART 3 - EXECUTION

### 3.1 COMMISSIONING AGENT'S DUTIES

- A. Cooperate with the Architect and Contractor and provide qualified personnel when scheduled.
- B. Promptly notify Architect and Contractor of irregularities or deficiencies in work that are observed during performance of services.
- C. Be present to observe all testing of all building envelope systems as defined in the Contract Documents.
- D. Commissioning Agent is not authorized to:
  - 1. Release, revoke, alter or expand requirements of Contract Documents.
  - 2. Approve or accept any portion of the work.
  - 3. Perform any duties of the Contractor.
- E. Submit a copy of the General Contractor's project and site specific Quality Assurance program to be implemented for construction for review by the Architect of Record, the Owner and the Commissioning Agent.

### 3.2 TESTING VERIFICATION

- A. At substantial completion of the project,
  - 1. The Construction Manager is to:
    - a. Certify that building envelope systems, subsystems, and construction have been completed according to the Contract Documents, including all addenda and change order requirements.
    - b. Certify that Field Quality Control procedures have been completed, and that field quality control reports have been submitted, discrepancies corrected, and corrective work approved. Provide a copy of the list of non-conformances maintained by the Construction Manager indicating all rework and corrections completed.
    - c. Provide sufficient notice to the Commissioning Agent regarding completion schedule for the assemblies or exterior enclosure systems. The Commissioning Agent will schedule functional tests through the Construction Manager
  - 2. The Commissioning Agent is to:
    - a. Verify that Field Quality Control procedures have been completed, and that field quality control reports have been submitted, discrepancies corrected, and corrective work approved.

- b. Annotate checklist or data sheets when a deficiency is observed.
  - c. Verify that field quality-control testing of building envelope has been completed and approved. The Commissioning Agent shall observe and document field quality-control tests and inspections.
  - d. The Commissioning Agent shall coordinate, observe and document the following tests conducted by the contractor, unless otherwise specified:
    - 1) Infrared thermography scan (performed by Commissioning Agent)
    - 2) Interior Pressure Testing Utilizing HVAC system in conjunction with IR thermography scan. (performed by Commissioning Agent)
3. All functional performance testing of building envelope/assemblies shall be performed by the contractor, unless otherwise specified. Any subcontractor or vendor responsible to execute a test shall provide assistance to the Commissioning Agent in developing the procedures review (answering questions about assemblies and sequences, etc.). Prior to execution, the Commissioning Agent will provide a copy of the test procedures to the Construction Manager and subcontractor(s) who will review the tests for feasibility, building enclosure/assemblies and warranty protection.

3.3 DEFERRED TESTING:

- A. If field tests cannot be completed because of a deficiency outside the scope of the Building Envelope, the deficiency shall be documented and reported to the Owner and the Architect-of-Record. Deficiencies shall be resolved and corrected by appropriate parties and the test rescheduled.

3.4 TESTING REPORTS:

- A. Testing reports shall include measured data, data sheets, and a comprehensive summary describing the specific building envelope systems at the time of testing.
- B. Prepare a preliminary test report. Deficiencies will be evaluated by the Architect to determine corrective action. Deficiencies shall be corrected and test repeated. All repairs are to be documented by the Commissioning Agent.
- C. If it is determined that the system is constructed according to the Contract Documents, the Owner will decide whether modifications are required to bring the performance of the system to a level where the failure or deficiency is eliminated and shall be implemented or if the test results will be accepted as submitted. If corrective Work is performed, the Owner will decide if tests shall be repeated, and a revised report is to be submitted.

END OF SECTION

SECTION 031000

CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" for a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

A. Section Includes:

- 1. Form-facing material for cast-in-place concrete.
- 2. Form liners.
- 3. Insulating concrete forms.
- 4. Waterstops.
- 5. Embedded items.
- 6. Shoring, bracing, and anchoring.

B. Related Requirements:

- 1. Section 321313 "Concrete Paving" for formwork related to concrete pavement and walks.
- 2. Section 321316 "Decorative Concrete Paving" for formwork related to decorative concrete pavement and walks.

1.3 DEFINITIONS

- A. Form-Facing Material: Temporary structure or mold for the support of concrete while the concrete is setting and gaining sufficient strength to be self-supporting.
- B. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

- 1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.
- 2. Review the following:

- a. Special inspection and testing and inspecting agency procedures for field quality control.
- b. Construction, movement, contraction, and isolation joints
- c. Forms and form-removal limitations.
- d. Anchor rod and anchorage device installation tolerances.

## 1.5 ACTION SUBMITTALS

### A. Product Data: For each of the following:

- 1. Exposed surface form-facing material.
- 2. Concealed surface form-facing material.
- 3. Forms for cylindrical columns.
- 4. Pan-type forms.
- 5. Void forms.
- 6. Form liners.
- 7. Insulating concrete forms.
- 8. Form ties.
- 9. Waterstops.
- 10. Dovetail anchors.
- 11. Form-release agent.

### B. Shop Drawings: Formwork plans prepared by, and signed and sealed by, a qualified professional engineer registered in the state of the project and responsible for their preparation, detailing fabrication, assembly, and support of forms.

- 1. For exposed vertical concrete walls, indicate dimensions and form tie locations.
- 2. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301 (ACI 301M).
  - a. Location of construction joints is subject to approval of the Architect.
- 3. Indicate location of waterstops.
- 4. Indicate applicable dead, live, and other loads for which the formwork has been designed.
- 5. Indicate proposed schedule and sequence of stripping of forms, and reshoring installation and removal.
- 6. Indicate layout of insulating concrete forms, dimensions, course heights, form types, and details.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing and inspection agency.
- B. Research Reports: For insulating concrete forms indicating compliance with International Code Council Acceptance Criteria AC308.
- C. Field quality-control reports.
- D. Minutes of preinstallation conference.

## 1.7 QUALITY ASSURANCE

- A. Testing and Inspection Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
- B. Mockups: Formed surfaces to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship.
  - 1. Build panel approximately 100 sq. ft. in the location indicated or, if not indicated, as directed by Architect.
  - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Insulating Concrete Forms: Store forms off ground and under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.
- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.
  - 1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
  - 2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.
    - a. For architectural concrete specified in Section 033300 "Architectural Concrete," limit deflection of form-facing material, studs, and walers to 0.0025 times their respective clear spans (L/400).
- B. Design, engineer, erect, shore, brace, and maintain insulating concrete forms in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.
  - 1. Design cross ties to transfer the effects of the following loads to the cast-in-place concrete core:
    - a. Wind Loads: As indicated on Drawings.
      - 1) Horizontal Deflection Limit: Not more than 1/360 of the wall height.



## 2.2 FORM-FACING MATERIALS

### A. As-Cast Surface Form-Facing Material:

1. Provide continuous, true, and smooth concrete surfaces.
2. Furnish in largest practicable sizes to minimize number of joints.
3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete, and as follows:
  - a. Plywood, metal, or other approved panel materials.
  - b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
    - 1) APA MDO (medium-density overlay); mill-release agent treated and edge sealed.

### B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.

1. Provide lumber dressed on at least two edges and one side for tight fit.

### C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class.

1. Provide forms with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

### D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation, with straight or tapered end forms.

## 2.3 WATERSTOPS

### A. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.

## 2.4 RELATED MATERIALS

### A. Reglets: Fabricate reglets of not less than 0.022-inch- (0.55-mm-) thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

### B. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch (0.85 mm) thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

### C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.

### D. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

### E. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
  2. Form release agent for form liners shall be acceptable to form liner manufacturer.
- F. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF FORMWORK

- A. Design, erect, shore, brace and maintain formwork according to ACI 301 (ACI 301M) to support vertical, lateral, static and dynamic loads, and construction loads, until structure can support such loads.
- B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 (ACI 117M) and to comply with the Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete" for as-cast finishes.
- C. Limit concrete surface irregularities as follows:
1. Surface Finish-3.0: ACI 117 Class A, 1/8 inch.
- D. Construct forms tight enough to prevent loss of concrete mortar.
1. Minimize joints.
  2. Exposed Concrete: Symmetrically align joints in forms.
- E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.
1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
  2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
  3. Install keyways, reglets, recesses, and other accessories, for easy removal.
- F. Do not use rust-stained, steel, form-facing material.
- G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.
1. Provide and secure units to support screed strips
  2. Use strike-off templates or compacting-type screeds.
- H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.
1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
  2. Locate temporary openings in forms at inconspicuous locations.

- I. Chamfer exterior corners and edges of permanently exposed concrete.
- J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches (305 mm).
- K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.
  - 1. Determine sizes and locations from trades providing such items.
  - 2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.
- L. Construction and Movement Joints:
  - 1. Construct joints true to line with faces perpendicular to surface plane of concrete.
  - 2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
  - 3. Place joints perpendicular to main reinforcement.
  - 4. Space vertical joints in walls as indicated on Drawings.
    - a. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
- M. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.
  - 1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
  - 2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.
- N. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- O. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- P. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

### 3.2 INSTALLATION OF EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. All embedded items shall be installed perpendicular to substrate surface unless otherwise indicated.
  - 1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
  - 3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
  - 4. Install dovetail anchor slots in concrete structures, as indicated on Drawings.

5. Clean embedded items immediately prior to concrete placement.
6. Post installed mechanical and adhesive anchors shall be installed per Manufacturer's Printed Installation Instructions (MPII), and in accordance with Section 050519 "Post Installed Anchors".

### 3.3 INSTALLATION OF WATERSTOPS

- A. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated on Drawings, according to manufacturer's written instructions, by adhesive bonding, mechanically fastening, and firmly pressing into place.
  1. Install in longest lengths practicable.
  2. Locate waterstops in center of joint unless otherwise indicated on Drawings.
  3. Protect exposed waterstops during progress of the Work.

### 3.4 REMOVING AND REUSING FORMS

- A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.
  1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
  2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work.
  1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.
  2. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.
  1. Align and secure joints to avoid offsets.
  2. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor to engage an independent qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- B. Inspections:
  1. Inspect formwork for shape, location, and dimensions of the concrete member being formed.
  2. Inspect insulating concrete forms for shape, location, and dimensions of the concrete member being formed.

END OF SECTION 031000

SECTION 033000

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" for a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

A. Section Includes:

1. Cast-in-place concrete, including reinforcement, concrete materials, mixture design, placement procedures, and finishes.

B. Related Requirements:

1. Section 312000 "Earth Moving" for drainage fill under slabs-on-ground.
2. Section 321313 "Concrete Paving" for concrete pavement and walks.
3. Section 031000 "Concrete Forming and Accessories" for formwork and embedded items.
4. Section 050519 "Post Installed Anchors" for post-installed anchors into concrete.
5. Section 051200 "Structural Steel Framing" for non-shrink grout.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

- B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents\03-Training and Guidance\03-Role Based Training and Guidance Documents\Contractor
2. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
  - a. Contractor's superintendent.
  - b. Independent testing agency responsible for concrete design mixtures.
  - c. Ready-mix concrete manufacturer.

- d. Concrete Subcontractor.
  - f. Special concrete finish Subcontractor.
3. Review the following:
- a. Special inspection and testing and inspecting agency procedures for field quality control.
  - b. Construction joints, control joints, isolation joints, and joint-filler strips.
  - c. Semirigid joint fillers.
  - d. Vapor-retarder installation.
  - e. Anchor rod and anchorage device installation tolerances.
  - f. Steel reinforcement installation.
  - g. Cold and hot weather concreting procedures.
  - h. Concrete finishes and finishing.
  - i. Curing procedures.
  - j. Forms and form-removal limitations.
  - k. Shoring and reshoring procedures.
  - l. Methods for achieving specified floor and slab flatness and levelness.
  - m. Floor and slab flatness and levelness measurements.
  - n. Concrete repair procedures.
  - o. Concrete protection.
  - p. Initial curing and field curing of field test cylinders (ASTM C31/C31M.)
  - q. Protection of field cured field test cylinders.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete mixture, include the following:
  - 1. Mixture identification, clearly indicating where mix is to be used on the Project.
  - 2. Minimum 28-day compressive strength.
  - 3. Durability exposure class.
  - 4. Maximum w/cm.
  - 5. Calculated equilibrium unit weight, for lightweight concrete.
  - 6. Slump limit.
  - 7. Air content.
  - 8. Nominal maximum aggregate size.
  - 9. Preconstruction test reports, for each mix design.
  - 10. Steel-fiber reinforcement content.
  - 11. Synthetic micro-fiber content.
  - 12. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
  - 13. Include certification from the admixture manufacturer that chloride content complies with specified requirements and ASTM C1582.
  - 14. Include certification from the admixture manufacturer that all admixtures are compatible with other required or proposed admixtures.
  - 15. Include manufacturer's certification that permeability-reducing admixture is compatible with mix design.
  - 16. Include certification that dosage rate for permeability-reducing admixture matches dosage rate used in performance compliance test.
  - 17. Include manufacturer's recommendation for corrosion inhibitor dosage rate specific to the Project.
  - 18. Intended placement method.

19. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Shop Drawings:

1. Steel Reinforcement Layout:
  - a. Comply with ACI SP-066.
  - b. Detail fabrication, bending and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and lap lengths, details of mechanical splice connectors, details of welding splices, tie and hoop spacing, and supports for concrete reinforcement.
2. Structural Thermal Break Insulated Connection System: Indicate general configuration, insulation dimensions, tension bars, compression pads, shear bars, and dimensions.
3. Sleeve Locations: Submit plan showing dimensioned locations and sizes of sleeves and openings for review by Architect and Engineer, prior to concrete placement.
4. Construction Joint Layout: Indicate dimensioned locations of proposed construction joints for concrete slabs and walls required to construct the structure.
  - a. Location of construction joints is subject to approval of the Architect.
5. Contraction (Crack Control) Joint Layout in Slabs on Grade: Indicate dimensioned location of proposed construction and control joints. Include proposed time frame for installation of control joints if by sawcutting methods as specified.
  - a. Location of construction and control joints is subject to approval of the Architect.

D. Samples: For vapor retarder.

E. Concrete Schedule: For each location of each type of concrete indicated in "Concrete Mixtures for Building Elements" Article, including the following:

1. Concrete type designation.
2. Location within Project.
3. Exposure Class designation.
4. Formed Surface Finish designation and final finish.
5. Final finish for floors.
6. Curing process.
7. Floor treatment if any.

## 1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Installer: Include copies of applicable ACI certificates.
2. Ready-mixed concrete manufacturer.
3. Testing agency: Include copies of applicable ACI certificates.

B. Welding Certificates.

1. Reinforcement to be welded: Welding procedure specification in accordance with AWS D1.4/D1.4M.



C. Material Certificates: For each of the following, signed by manufacturers certifying that each material item complies with or exceeds the specified requirements:

1. Cementitious materials.
2. Admixtures.
3. Steel reinforcement and accessories.
4. Fiber reinforcement.
5. Curing compounds.
6. Floor and slab treatments.
7. Bonding agents.
8. Adhesives.
9. Vapor retarders.
10. Semirigid joint filler.
11. Joint-filler strips.
12. Repair materials.

D. Material Test Reports: For the following, from a qualified testing agency:

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Blended hydraulic cement.
5. Silica fume.
6. Performance-based hydraulic cement.
7. Aggregates:
  - a. Include service record data indicating absence of deleterious expansion of concrete due to alkali reactivity.
8. Admixtures:
  - a. Permeability-Reducing Admixture: Include independent test reports, indicating compliance with specified requirements, including dosage rate used in test.
9. Steel Reinforcement:
  - a. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.
10. Mechanical Splice Couplers.

E. Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances.

F. Research Reports:

1. For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.
2. For sheet vapor retarder/termite barrier, showing compliance with ICC AC380.

G. Field quality-control reports.

H. Minutes of preinstallation conference.

## 1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACI Flatwork

Concrete Finisher/Technician or an ACI Concrete Flatwork Technician with experience installing and finishing concrete, incorporating permeability-reducing admixtures.

- B. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
  - 1. Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Control Technical Manager.
  - 1. Personnel performing laboratory tests shall be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.
- D. Field Quality Control Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
  - 1. Personnel conducting field tests shall be qualified as an ACI Concrete Field Testing Technician, Grade 1, in accordance with ACI CPP 610.1 or an equivalent certification program.
- E. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4/D 1.4M.
- F. Mockups: Cast concrete slab-on-ground and formed-surface panels to demonstrate typical joints, surface finish, texture, tolerances, floor treatments, and standard of workmanship.
  - 1. Slab-On-Ground: Build panel approximately 15 feet by 15 feet in the location indicated or, if not indicated, as directed by Architect.
    - a. Divide panel into four equal panels to demonstrate saw joint cutting.
  - 2. Formed Surfaces: Build panel approximately 100 sq. ft. in the location indicated or, if not indicated, as directed by Architect.
  - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.8 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.
  - 1. Include the following information in each test report:
    - a. Admixture dosage rates.
    - b. Slump.
    - c. Air content.
    - d. Seven-day compressive strength.

- e. 28-day compressive strength.
- f. Permeability.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Comply with ASTM C94/C94M and ACI 301 (ACI 301M).
- B. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. and to avoid damaging coatings on steel reinforcement.
  - 1. Store reinforcement to avoid contact with earth.
  - 2. Do not allow epoxy-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
  - 3. Do not allow dual-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
  - 4. Do not allow stainless steel reinforcement to come into contact with uncoated reinforcement.

## 1.10 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with ACI 301 (ACI 301M) and ACI 306.1 and as follows.
  - 1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
  - 2. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301 (ACI 301M).
  - 3. Do not use frozen materials or materials containing ice or snow.
  - 4. Do not place concrete in contact with surfaces less than 35 deg F (1.7 deg C), other than reinforcing steel.
  - 5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- B. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and ACI 305.1 (ACI 305.1M), and as follows:
  - 1. Maintain concrete temperature at time of discharge to not exceed 95 deg F (35 deg C).
  - 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

## PART 2 - PRODUCTS

### 2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with ACI 301 (ACI 301M) and ACI 117 (ACI 117M) unless modified by requirements in the Contract Documents.

### 2.2 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60 (Grade 420), deformed.

- B. Headed-Steel Reinforcing Bars: ASTM A970/A970M.
- C. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.

### 2.3 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A615/A615M, Grade 60 (Grade 420), plain-steel bars, cut true to length with ends square and free of burrs.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.
  - 1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
    - a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
- C. Mechanical Splice Couplers: ACI 318 (ACI 318M) Type 1, same material of reinforcing bar being spliced; dowel-bar type or mechanical-lap type.
- D. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch (1.2908 mm) in diameter.
  - 1. Finish: Plain.

### 2.4 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

### 2.5 CONCRETE MATERIALS

- A. Source Limitations:
  - 1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
  - 2. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
  - 3. Obtain aggregate from single source.
- B. Admixture Limitations:
  - 1. Admixtures shall conform to ASTM C1582 for inhibiting chloride-induced corrosion.
  - 2. Calcium chloride or admixtures that contribute water-soluble chloride ions exceeding those permitted in hardened concrete shall not be used.
  - 3. Specific admixtures, including admixtures listed within this section, are acceptable only if manufacturer can submit evidence of product compatibility with other products within the same concrete mix.
- C. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, Type I or Type III, gray.
  2. Fly Ash: ASTM C618, Class C or F.
  3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
  4. Blended Hydraulic Cement: ASTM C595/C595M, Type IS, portland blast-furnace slag Type IP, portland-pozzolan cement.
  5. Silica Fume: ASTM C1240 amorphous silica.
- D. Normal-Weight Aggregates: ASTM C33/C33M, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source.
1. Alkali-Silica Reaction: Comply with one of the following:
    - a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.
    - b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.
    - c. Alkali Content in Concrete: Not more than 4 lb./cu. yd. (2.37 kg/cu. m) for moderately reactive aggregate or 3 lb./cu. yd. (1.78 kg/cu. m) for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301 (ACI 301M).
  2. Maximum Coarse-Aggregate Size: See "Concrete Mixtures for Building Elements".
  3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- E. Lightweight Aggregate: ASTM C330/C330M. See "Concrete Mixtures for Building Elements" for nominal maximum aggregate size. Aggregates shall be suitably processed, washed and screened, and shall consist of durable particles without adherent coatings.
- F. Air-Entraining Admixture: ASTM C260/C260M.
- G. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
  2. Retarding Admixture: ASTM C494/C494M, Type B.
  3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
  4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
  5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
  6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
  7. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.
    - a. Products: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      - 1) BASF Corporation. MasterLife CI 222 (Pre-2014: Rheocrete 222+)
      - 2) Cortec Corporation. MCI-2005 NS
      - 3) GCP Applied Technologies Inc. DCI-S
      - 4) Sika Corporation. FerroGard-901S

5) Specialty Products Group. Vapor Lock 40/40

- b. Dosage Rate: Shall be per manufacturer's recommendation specific to the Project. Manufacturer's recommendation shall be included with material certificate submittal on manufacturer's letterhead.

- H. Water and Water Used to Make Ice: ASTM C94/C94M, potable.
1. Free of foreign matter that may be harmful to concrete, reinforcement, or concrete accessories, including but not limited to oils, acids, alkalies, salts, and organic materials.
  2. Free of deleterious amounts of chloride ions.

2.6 VAPOR RETARDERS

- A. Sheet Vapor Retarder, Class A: ASTM E1745, Class A; not less than 15 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive tape.

2.7 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

2.8 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Products: Subject to compliance with requirements, provide one of the following or approved equal:

- a. BASF Corporation; MasterKure ER 50.
- b. ChemMasters, Inc; Spray-Film.
- c. Dayton Superior; AquaFilm Concentrate J74.
- d. Euclid Chemical Company (The); an RPM company; Eucobar.
- e. Kaufman Products, Inc; VaporAid.
- f. Sika Corporation; SikaFilm.
- g. SpecChem, LLC; Spec Film.
- h. W.R. Meadows, Inc; EVAPRE.

- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.

- C. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.

1. Color:

- a. Ambient Temperature Below 50 deg F (10 deg C): Black.
- b. Ambient Temperature between 50 deg F (10 deg C) and 85 deg F (29 deg C): Any color.
- c. Ambient Temperature Above 85 deg F (29 deg C): White.

- D. Water: Potable or complying with ASTM C1602/C1602M.

- E. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B.
1. Products: Subject to compliance with requirements, provide one of the following or approved equal:
    - a. BASF Corporation; MasterKure CC 160 WB.
    - b. ChemMasters, Inc; Safe-Cure Clear DR.
    - c. Euclid Chemical Company (The); an RPM company; Kurez DR VOX.
    - d. Kaufman Products, Inc; ThinFilm 420.
    - e. SpecChem, LLC; SpecRez.
    - f. TK Products; DC WB Dissipating Cure 2519.
    - g. Vexcon Chemicals Inc.; Certi-Vex Envio Cure 100.
    - h. W.R. Meadows, Inc; 1100-CLEAR.
- F. Clear, Waterborne, Membrane-Forming, Curing Compound: ASTM C309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.
1. Products: Subject to compliance with requirements, provide one of the following or approved equal:
    - a. BASF Corporation; MasterKure CC 180 WB.
    - b. ChemMasters, Inc; Polyseal WB.
    - c. Euclid Chemical Company (The); an RPM company; EverClear VOX.
    - d. Kaufman Products, Inc; Krystal 25 Emulsion.
    - e. Nox-Crete Products Group; Cure & Seal 200 E.
    - f. SpecChem, LLC; Cure & Seal WB 25.
    - g. Vexcon Chemicals Inc.; StarSeal 800.
    - h. W.R. Meadows, Inc; Vocomp-20.
- G. Clear, Waterborne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.
1. Products: Subject to compliance with requirements, provide one of the following or approved equal:
    - a. ChemMasters, Inc; Polyseal WB.
    - b. Euclid Chemical Company (The); an RPM company; Super Diamond Clear VOX.
    - c. Kaufman Products, Inc; Krystal 25 Emulsion.
    - d. Nox-Crete Products Group; Cure & Seal 250E.
    - e. SpecChem, LLC; Cure & Seal WB 25.
    - f. TK Products; TK-Bright Kure & Seal 1315 VOC.
    - g. Vexcon Chemicals Inc.; StarSeal 1315.
    - h. W.R. Meadows, Inc; Vocomp-30.

## 2.9 BUILT-UP EXPANDED POLYSTYRENE (EPS)

- A. Expanded Polystyrene: ASTM D6817, and the following:
1. Density: ASTM D1622, 1.25 pcf (0.2 kN/m<sup>3</sup>)
  2. Compressive Strength: ASTM D1621, 5.8 psi (40 kPa) at 1% deformation and 16.0 psi (110 kPa) at 10% deformation.
  3. Flexural Strength: ASTM C203, 30 psi (207 kPa)

4. Manufacturer: Available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Cellofoam North America.
  - b. Dow Chemical Company (The).
  - c. Geofam International.
  - d. InsulFoam
  - e. Universal Foam Products.
5. Connectors: Galvanized steel multi-barbed connectors or a urethane adhesive. Each connector shall have a lateral holding strength of at least 60 lbs (27.22 kg) when tested with product.

#### 2.10 BUILT-UP EXTRUDED POLYSTYRENE (XPS)

- A. Built-up Extruded Polystyrene: Extruded polystyrene board insulation, ASTM C 578, Type IV, 1.45 lb/ cubic ft density, 25 psi minimum compressive strength.
  1. Manufacturer: Available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. DiversiFoam Products.
    - b. Dow Chemical Company (The).
    - c. Owens Corning.
    - d. Kingspan Group.
  2. Connectors: Manufacturer's multi-barbed, galvanized steel sheet connectors or deformed steel reinforcing bars, 3/4 inch diameter.

#### 2.11 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D1752, cork or self-expanding cork.
- B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 in accordance with ASTM D2240.
- C. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene. Use in strict conformance with manufacturer's written recommended application limitations, precautions, directions for use, including but not limited to surface preparation, mixing, placing, curing, and compatibility with substrate conditions.
- D. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements. Use in strict conformance with manufacturer's written recommended application limitations, precautions, directions for use, including but not limited to surface preparation, mixing, placing, curing, and compatibility with substrate conditions and as follows:
  1. Types I and II, nonload bearing and Types IV and V, load bearing: for bonding hardened or freshly mixed concrete to hardened concrete.

#### 2.12 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3 mm) and that can be feathered at edges to match adjacent floor elevations.



1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
  2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
  3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3 to 6 mm) or coarse sand, as recommended by underlayment manufacturer.
  4. Compressive Strength: Not less than 5000 psi (34.5 MPa) at 28 days when tested in accordance with ASTM C109/C109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch (6 mm) and that can be filled in over a scarified surface to match adjacent floor elevations.
1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
  2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
  3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by topping manufacturer.
  4. Compressive Strength: Not less than 5000 psi (34.5 MPa) at 28 days when tested in accordance with ASTM C109/C109M.

## 2.13 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301 (ACI 301M).
1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
1. Fly Ash or Other Pozzolans: 25 percent by mass.
  2. Slag Cement: 50 percent by mass.
  3. Silica Fume: 10 percent by mass.
  4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
- C. Limit water-soluble chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- D. Admixtures: Use admixtures in accordance with manufacturer's written instructions.
1. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
  2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
  3. Use water-reducing admixture in pumped concrete, and concrete with a w/cm below 0.50.
  4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
  5. Use permeability-reducing admixture in concrete mixtures where indicated.

## 2.14 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Footings and Isolated Piers within the building envelope: Normal-weight concrete.
1. Exposure Class: ACI 318 (ACI 318M) F0 S0 W0 C1.
  2. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
  3. Maximum w/cm: 0.55.
  4. Slump Limit: 4 inches (100 mm) plus or minus 1 inch (25 mm); 8 inches (200 mm) plus or minus 1 inch (25 mm) for concrete with verified slump of 3 inches (75 mm) plus or minus 1 inch (25 mm) before adding high-range water-reducing admixture or plasticizing admixture at Project site.
  5. Maximum Coarse Aggregate Size: 1-1/2-inch (38-mm) nominal.
- B. Basement Walls and Integral Piers within the building envelope: Normal-weight concrete.
1. Exposure Class: ACI 318 (ACI 318M) F1 S0 W0 C1.
  2. Minimum Compressive Strength: 4500 psi (31 MPa) at 28 days.
  3. Maximum w/cm: 0.45.
  4. Slump Limit: 4 inches (100 mm), plus or minus 1 inch (25 mm), 8 inches (200 mm), plus or minus 1 inch (25 mm) for concrete with verified slump of 3 inches (75 mm), plus or minus 1 inch (25 mm), before adding high-range water-reducing admixture or plasticizing admixture at Project site.
  5. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery.
  6. Maximum Coarse Aggregate Size: 3/4-inch (19-mm) nominal.
- C. Perimeter Knee Walls, Site Retaining Walls, Exterior Piers or Columns: Normal-weight concrete.
1. Exposure Class: ACI 318 (ACI 318M) F2 S0 W0 P0 C1.
  2. Minimum Compressive Strength: 4500 psi (31 MPa) at 28 days.
  3. Maximum w/cm: 0.45.
  4. Slump Limit: 4 inches (100 mm), plus or minus 1 inch (25 mm); 8 inches (200 mm), plus or minus 1 inch (25 mm) for concrete with verified slump of 3 inches (75 mm), plus or minus 1 inch (25 mm), before adding high-range water-reducing admixture or plasticizing admixture at Project site.
  5. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery.
  6. Maximum Coarse Aggregate Size: 3/4-inch (19-mm) nominal.
- D. Interior Slabs-On-Grade: Normal-weight concrete.
1. Exposure Class: ACI 318 (ACI 318M) F0 S0 C0.
  2. Minimum Compressive Strength: 3500 psi (24.1 MPa) at 28 days.
  3. Maximum w/cm: 0.55.
  4. Slump Limit: 4 inches (100 mm) plus or minus 1 inch (25 mm).
  5. Air Content: Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.
  6. Maximum Coarse-Aggregate Size: 3/4 inch, nominal. Finished floors to be colored, polished, or exposed to view as the final floor finish shall have a maximum coarse aggregate size of 1/2 inch.
- E. Exterior, Exposed Slabs-on-Grade, Ramps, Stairs and Stoops: Normal-weight concrete.
1. Exposure Class: ACI 318 (ACI 318M) F3 S0 W0 C2.
  2. Minimum Compressive Strength: 5000 psi (34.5 MPa) at 28 days.
  3. Maximum w/cm: 0.40.
  4. Slump Limit: 4 inches (100 mm), plus or minus 1 inch (25 mm).
  5. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery.
  6. Maximum Coarse-Aggregate Size: 3/4 inch, nominal.
- F. Interior Elevated Slabs on Metal Deck: Structural lightweight concrete.

1. Exposure Class: ACI 318 (ACI 318M) F0 S0 C0.
2. Minimum Compressive Strength: 3500 psi (24.1 MPa) at 28 days.
3. Calculated Equilibrium Unit Weight: 112 lb/cu. ft. (1794 kg/cu. m), plus or minus 3 lb/cu. ft. (48.1 kg/cu. m) as determined by ASTM C567/C567M.
4. Slump Limit: 4 inches (100 mm), plus or minus 1 inch (25 mm); 8 inches (200 mm), plus or minus 1 inch (25 mm) for concrete with verified slump of 3 inches (75 mm), plus or minus 1 inch (25 mm), before adding high-range water-reducing admixture or plasticizing admixture at Project site.
5. Air Content:
  - a. As recommended by the concrete supplier, but in no case shall be less than 4 percent or greater than 6 percent.
6. Maximum Coarse-Aggregate Size: 3/4 inch, nominal. Finished floors to be colored, polished, or exposed to view as the final floor finish shall have a maximum coarse aggregate size of 1/2 inch. Maximum aggregate sizes of concrete toppings shall not exceed 1/3 depth of slab.

G. Interior Toppings: Normal-weight concrete.

1. Exposure Class: ACI 318 (ACI 318M) F0 S0 C0.
2. Minimum Compressive Strength: 3500 psi (24.1 MPa) at 28 days.
3. Maximum w/cm: 0.55.
4. Slump Limit: 4 inches (100 mm), plus or minus 1 inch (25 mm).
5. Air Content: Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.
6. Maximum Coarse-Aggregate Size: 3/4 inch, nominal. Finished floors to be colored, polished, or exposed to view as the final floor finish shall have a maximum coarse aggregate size of 1/2 inch.

## 2.15 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M and ASTM C1116/C1116M, and furnish batch ticket information.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete in accordance with ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.
  1. For mixer capacity of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
  2. For mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
  3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verification of Conditions:

1. Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
2. Do not proceed until unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:
  1. Daily access to the Work.
  2. Incidental labor and facilities necessary to facilitate tests and inspections.
  3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
  4. Security and protection for test samples and for testing and inspection equipment at Project site.
- B. Protection of In-Place Conditions:
  1. Do not cut or puncture vapor retarder.
  2. Repair damage and reseal vapor retarder before placing concrete.
- C. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

### 3.3 INSTALLATION OF VAPOR RETARDER

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.
  1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
  2. Face laps away from exposed direction of concrete pour.
  3. Lap vapor retarder over footings and grade beams not less than 6 inches (150 mm), sealing vapor retarder to concrete.
  4. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended tape.
  5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
  6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
  7. Protect vapor retarder during placement of reinforcement and concrete.
    - a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches (150 mm) on all sides, and sealing to vapor retarder.
- B. Granular Course: Cover vapor barrier with granular fill, moisten, and compact with mechanical equipment to elevation tolerance of 0 inch (0 mm), plus or minus 3/4 inch (19 mm).

### 3.4 INSTALLATION OF STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.
- B. Accurately position, support, and secure reinforcement against displacement.

1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
  2. Do not tack weld crossing reinforcing bars.
- C. Preserve clearance between bars of not less than 1 inch (25 mm), not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.
- D. Provide concrete coverage in accordance with ACI 318 (ACI 318M).
- E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- F. Splices: Lap splices as indicated on Drawings.
1. Bars indicated to be continuous, and all vertical bars shall be lapped not less than 36 bar diameters at splices, or 24 inches (610 mm), whichever is greater.
  2. Stagger splices in accordance with ACI 318 (ACI 318M).
  3. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.
  4. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.
- G. Install structural thermal break insulated connection system in accordance with manufacturer's instructions.
- H. Install welded-wire reinforcement in longest practicable lengths.
1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."
    - a. For reinforcement less than W4.0 or D4.0, continuous support spacing shall not exceed 12 inches (305 mm).
  2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches (50 mm) for plain wire and 8 inches (200 mm) for deformed wire.
  3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
  4. Lace overlaps with wire.

### 3.5 JOINTS

- A. Construct joints true to line, with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.
1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
  2. Place joints perpendicular to main reinforcement.
    - a. Continue reinforcement across construction joints unless otherwise indicated.
    - b. Do not continue reinforcement through sides of strip placements of floors and slabs.
  3. Provide dowels across construction joints as indicated. Dowels shall be supported during concrete operations so as to remain parallel with slab or wall surface and perpendicular to the joint.

4. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) deep by one-third the thickness of the concrete wall or slab, continuous in walls, slabs, and between walls and footings, unless otherwise noted on drawings.
  5. For structural beams, slabs, joists, and girders horizontal spacing of construction joints shall not exceed 90 feet in each direction. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
  6. For slabs on metal deck, horizontal spacing of construction joints shall not exceed 90 feet in each direction.
  7. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
  8. Space vertical joints in foundation walls as indicated on Drawings, or a maximum of 30'-0" on center, whichever is more stringent. Unless otherwise indicated on Drawings, locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.
  9. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
  10. Where possible, avoid construction joints in areas specified to receive thin-set tile, terrazzo, or resilient floor finish materials. If unavoidable, Contractor shall coordinate the joint location with the Architect. Slab grinding, chipping, and filling at such occurrences to achieve specified floor tolerances will be at Contractor's expense.
- C. Contraction Joints in Slabs-on-Ground (also referred to as "Crack Control Joints"): Form weakened-plane control joints. Joints shall be placed at a maximum 15 feet on center in any direction, unless otherwise indicated by the documents, or written approval is given by the Engineer. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3.2 mm). Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
  2. Sawed Joints: Comply with recommendations of ACI 301. Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.
    - a. Initial saw cuts shall be performed no more than three hours after final surface finishing of the slab, with equipment specifically suited and designed for early concrete saw cutting (dry cut saw) without dislodging aggregate. Perform final saw cuts as soon as possible to achieve specified joint size.
- D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.
  2. Terminate full-width joint-filler strips not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished concrete surface, where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
  3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Joints:
1. Install dowel bars and support assemblies at joints where indicated on Drawings.

2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.
- F. Dowel Plates: Install dowel plates at joints where indicated on Drawings.

### 3.6 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.
1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
  2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.
- B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.
- C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301 (ACI 301M), but not to exceed the amount indicated on the concrete delivery ticket.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.
1. If a section cannot be placed continuously, provide construction joints as indicated.
  2. Deposit concrete to avoid segregation.
  3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
  4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301 (ACI 301M).
    - a. Do not use vibrators to transport concrete inside forms.
    - b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer.
    - c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
    - d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Do not place concrete floors and slabs in a checkerboard sequence.
  2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  3. Maintain reinforcement in position on chairs during concrete placement.
  4. Screed slab surfaces with a straightedge and strike off to correct elevations.
  5. Level concrete, cut high areas, and fill low areas.

6. Slope surfaces uniformly to drains where required.
7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

### 3.7 FINISHING FORMED SURFACES

#### A. As-Cast Surface Finishes:

1. ACI 301 (ACI 301M) Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.
  - a. Patch voids larger than 1-1/2 inches (38 mm) wide or 1/2 inch (13 mm) deep.
  - b. Remove projections larger than 1 inch (25 mm).
  - c. Tie holes do not require patching.
  - d. Surface Tolerance: ACI 117 (ACI 117M) Class D.
  - e. Apply to concrete surfaces not exposed to public view.
2. ACI 301 (ACI 301M) Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.
  - a. Patch voids larger than 3/4 inch (19 mm) wide or 1/2 inch (13 mm) deep.
  - b. Remove projections larger than 1/8 inch (3 mm).
  - c. Patch tie holes.
  - d. Surface Tolerance: ACI 117 (ACI 117M) Class B.
  - e. Locations: Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.
3. ACI 301 (ACI 301M) Surface Finish SF-3.0:
  - a. Patch voids larger than 3/4 inch (19 mm) wide or 1/2 inch (13 mm) deep.
  - b. Remove projections larger than
  - c. Patch tie holes.
  - d. Surface Tolerance: ACI 117 (ACI 117M) Class A.
  - e. Locations: Apply to concrete surfaces as indicated on architectural drawings.

#### B. Rubbed Finish: Apply the following to as cast surface finishes where indicated on Drawings:

1. Smooth-Rubbed Finish:
  - a. Perform no later than one day after form removal.
  - b. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture.
  - c. If sufficient cement paste cannot be drawn from the concrete by the rubbing process, use a grout made from the same cementitious materials used in the in-place concrete.
  - d. Maintain required patterns or variances as shown on Drawings or to match mockups.
2. Grout-Cleaned Rubbed Finish:
  - a. Clean concrete surfaces after contiguous surfaces are completed and accessible.



- b. Do not clean concrete surfaces as Work progresses.
  - c. Mix 1 part portland cement to 1-1/2 parts fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
  - d. Wet concrete surfaces.
  - e. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap, and keep surface damp by fog spray for at least 36 hours.
  - f. Maintain required patterns or variances as shown on Drawings or to match mockups.
3. Cork-Floated Finish:
- a. Mix 1 part portland cement to 1 part fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint.
  - b. Mix 1 part portland cement and 1 part fine sand with sufficient water to produce a mixture of stiff grout. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
  - c. Wet concrete surfaces.
  - d. Compress grout into voids by grinding surface.
  - e. In a swirling motion, finish surface with a cork float.
  - f. Maintain required patterns or variances as shown on Drawings or to match mockups.
4. Scrubbed Finish: After concrete has achieved a compressive strength of from 1000 to 1500 psi (6.9 to 10.3 MPa), apply scrubbed finish.
- a. Wet concrete surfaces thoroughly and scrub with stiff fiber or wire brushes, using water freely, until top mortar surface is removed and aggregate is uniformly exposed.
  - b. Rinse scrubbed surfaces with clean water.
  - c. Maintain continuity of finish on each surface or area of Work.
  - d. Remove only enough concrete mortar from surfaces to match mockups.
- C. Abrasive-Blast Finish: Apply the following to as-cast surface finishes where indicated on Drawings:
- 1. Perform abrasive blasting after compressive strength of concrete exceeds 2000 psi (13.8 MPa).
  - 2. Coordinate with formwork removal to ensure that surfaces to be abrasive blasted are treated at the same age.
  - 3. Surface Continuity:
    - a. Perform abrasive-blast finishing as continuous operation, maintaining continuity of finish on each surface or area of Work.
    - b. Maintain required patterns or variances in depths of blast to match mockups.
  - 4. Abrasive Blasting:
    - a. Abrasive-blast corners and edges of patterns carefully, using backup boards to maintain uniform corner and edge lines.
    - b. Determine type of nozzle pressure and blasting techniques required to match field sample.

- c. Depth of Cut: Use an abrasive grit of proper type and gradation to expose aggregate and surrounding matrix surfaces to match field sample, as follows:
    - 1) Brush Texture: Remove cement matrix to dull surface sheen and expose face of fine aggregate, with no significant reveal.
    - 2) Light Texture: Expose fine aggregate with occasional exposure of coarse aggregate and uniform color, with maximum reveal of 1/16 inch (1.5 mm).
    - 3) Medium Texture: Generally, expose coarse aggregate with slight reveal and with a maximum reveal of 1/4 inch (6 mm).
    - 4) Heavy Texture: Expose and reveal coarse aggregate to a maximum projection of one-third its diameter, with reveal range of 1/4 to 1/2 inch (6 to 13 mm).
  - d. Maintain required patterns or variances in reveal projection to match mockups.
- D. High-Pressure Water-Jet Finish: Apply the following to as-cast surface finishes where indicated on Drawings:
- 1. Perform high-pressure water jetting on concrete that has achieved a minimum compressive strength of 4500 psi (31 MPa).
  - 2. Coordinate with formwork removal to ensure that surfaces to be high-pressure water-jet finished are treated at same age for uniform results.
  - 3. Surface Continuity: Perform high-pressure water-jet finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work.
  - 4. Maintain required patterns or variances in reveal projection to match mockups.
- E. Bushhammer Finish: Apply the following to as-cast surface finishes where indicated on Drawings:
- 1. Perform bushhammer finish to concrete that has achieved a minimum compressive strength of 4500 psi (31 MPa).
  - 2. Surface Continuity:
    - a. Perform bushhammer finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work.
  - 3. Surface Cut:
    - a. Maintain required depth of cut and general aggregate exposure.
    - b. Use power tool with hammer attachments for large, flat surfaces, and use hand hammers for small areas, at corners and edges, and for restricted locations where power tools cannot reach.
  - 4. Remove impressions of formwork and form facings with exception of tie holes.
  - 5. Maintain required patterns or variances of cut as shown on Drawings or to match mockups.
  - 6. Maintain control of concrete chips, dust, and debris in each Work area, limiting migration of airborne materials and dust by use of tarpaulins, wind-breaks, or similar devices.
- F. Related Unformed Surfaces:
- 1. At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a color and texture matching adjacent formed surfaces.

2. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

### 3.8 FINISHING FLOORS AND SLABS

- A. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish:
  1. While still plastic, texture concrete surface that has been screeded and bull-floated or darbied.
  2. Use stiff brushes, brooms, or rakes to produce a profile depth of 1/4 inch (6 mm) in one direction.
  3. Apply scratch finish to surfaces indicated, to receive concrete floor toppings, and to receive mortar setting beds for bonded cementitious floor finishes.
- C. Float Finish:
  1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
  2. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 (ACI A117M) tolerances for conventional concrete.
  3. Apply float finish to surfaces indicated, to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
- D. Trowel Finish:
  1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
  2. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
  3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
  4. Do not add water to concrete surface.
  5. Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
  6. Apply a trowel finish to surfaces indicated, exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
  7. Finish surfaces to the following tolerances, in accordance with ASTM E1155, for a randomly trafficked floor surface:
    - a. Slabs on Ground:
      - 1) Specified overall values of flatness,  $F_F$  45; and of levelness,  $F_L$  35; with minimum local values of flatness,  $F_F$  30; and of levelness,  $F_L$  24.
    - b. Suspended Slabs:
      - 1) Specified overall values of flatness,  $F_F$  35; and of levelness,  $F_L$  20; with minimum local values of flatness,  $F_F$  24; and of levelness,  $F_L$  15.

- E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated on Drawings and where ceramic or quarry tile is to be installed by either thickset or thinset method. While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.
  - 1. Coordinate required final finish with Architect before application.
  - 2. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.
- F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.
  - 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
  - 2. Coordinate required final finish with Architect before application.

### 3.9 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

- A. Filling In:
  - 1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
  - 2. Mix, place, and cure concrete, as specified, to blend with in-place construction.
  - 3. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Pads and Foundations: Normal weight concrete, unless otherwise noted.
  - 1. Coordinate sizes and locations of concrete bases with actual equipment provided.
  - 2. Construct concrete bases 4 inches (100 mm) high unless otherwise indicated on Drawings, and extend base not less than 6 inches (150 mm) in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
  - 3. Minimum Compressive Strength: 5000 psi (34.5 MPa) for exterior concrete bases, and 3500 psi (24.1 MPa) for interior concrete bases, at 28 days.
  - 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
  - 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
  - 6. Prior to pouring concrete, place and secure anchorage devices.
    - a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    - b. Cast anchor-bolt insert into bases.
    - c. Install anchor bolts to elevations required for proper attachment to supported equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items.
  - 1. Cast-in inserts and accessories, as shown on Drawings.
  - 2. Screed, tamp, and trowel finish concrete surfaces.

### 3.10 BUILT-UP EXPANDED POLYSTYRENE (EPS) INSTALLATION

- A. Install built-up extruded polystyrene in layers with abutting edges and ends and with the long dimension of each block at right angles to blocks in each subsequent layer. The surface of a layer to receive additional layers shall be constructed with a variation in surface tolerance of no more than 15 mm (0.05 feet) in any 3 m (10 ft) interval. All blocks shall accurately fit relative to adjacent blocks. No gaps greater than 20 mm (0.07ft) will be allowed on vertical joints.
- B. Blocks placed in a row in a particular layer shall be offset. In order to avoid continuous joints, each subsequent layer of blocks shall be rotated on the horizontal plane 90 degrees from the direction of placement of the previous layer placed.
- C. Because of the light unit-weight of the EPS fill, it is the Contractor's responsibility to provide temporary weighting and/or guying as necessary until all the blocks are built into a homogeneous mass, and the pavement section as well as any soil cover are in place.
- D. Install all connectors at each layer to resist horizontal displacement according to manufacturer's printed installation instructions (MPII).

### 3.11 BUILT-UP EXTRUDED POLYSTYRENE (XPS) INSTALLATION

- A. Install built-up extruded polystyrene in layers with abutting edges and ends and with the long dimension of each block at right angles to blocks in each subsequent layer. Offset joints in successive layers.
- B. Install all connectors at each layer to resist horizontal displacement according to manufacturer's printed installation instructions (MPII).

### 3.12 CONCRETE CURING

- A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
  - 1. Comply with ACI 301 (ACI 301M) and ACI 306.1 for cold weather protection during curing.
  - 2. Comply with ACI 301 (ACI 301M) and ACI 305.1 (ACI 305.1M) for hot-weather protection during curing.
  - 3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h (1 kg/sq. m x h), calculated in accordance with ACI 305.1, before and during finishing operations.
- B. Curing Formed Surfaces: Comply with ACI 308.1 (ACI 308.1M) as follows:
  - 1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
  - 2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
  - 3. If forms remain during curing period, moist cure after loosening forms.
  - 4. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:
    - a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
    - b. Continuous Sprinkling: Maintain concrete surface continuously wet.

- c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
- d. Water-Retention Sheetting Materials: Cover exposed concrete surfaces with sheetting material, taping, or lapping seams.
- e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
  - 1) Recoat areas subject to heavy rainfall within three hours after initial application.
  - 2) Maintain continuity of coating and repair damage during curing period.

C. Curing Unformed Surfaces: Comply with ACI 308.1 (ACI 308.1M) as follows:

- 1. Begin curing immediately after finishing concrete.
- 2. Interior Concrete Floors:
  - a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:
    - 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
      - a) Lap edges and ends of absorptive cover not less than 12-inches (300-mm).
      - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
    - 2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive.
      - a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
      - b) Cure for not less than seven days.
    - 3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
      - a) Water.
      - b) Continuous water-fog spray.
  - b. Floors to Receive Penetrating Liquid Floor Treatments: Contractor has option of the following:
    - 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
      - a) Lap edges and ends of absorptive cover not less than 12 inches (300 mm).

- b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
  - 2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive.
    - a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
    - b) Cure for not less than seven days.
  - 3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
    - a) Water.
    - b) Continuous water-fog spray.
- c. Floors to Receive Polished Finish: Contractor has option of the following:
- 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
    - a) Lap edges and ends of absorptive cover not less than 12 inches (300 mm).
    - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
  - 2) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
    - a) Water.
    - b) Continuous water-fog spray.
- d. Floors to Receive Chemical Stain:
- 1) As soon as concrete has sufficient set to permit application without marring concrete surface, install curing paper over entire area of floor.
  - 2) Install curing paper square to building lines, without wrinkles, and in a single length without end joints.
  - 3) Butt sides of curing paper tight; do not overlap sides of curing paper.
  - 4) Leave curing paper in place for duration of curing period, but not less than 28 days.
- e. Floors to Receive Urethane Flooring:
- 1) As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
  - 2) Rewet absorptive cover, and cover immediately with polyethylene moisture-retaining cover with edges lapped 6 inches (150 mm) and sealed in place.
  - 3) Secure polyethylene moisture-retaining cover in place to prohibit air from circulating under polyethylene moisture-retaining cover.

- 4) Leave absorptive cover and polyethylene moisture-retaining cover in place for duration of curing period, but not less than 28 days.

f. Floors to Receive Curing Compound:

- 1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
- 2) Recoat areas subjected to heavy rainfall within three hours after initial application.
- 3) Maintain continuity of coating, and repair damage during curing period.
- 4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.

g. Floors to Receive Curing and Sealing Compound:

- 1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
- 2) Recoat areas subjected to heavy rainfall within three hours after initial application.
- 3) Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

### 3.13 TOLERANCES

- A. Conform to ACI 117 (ACI 117M).

### 3.14 APPLICATION OF LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment in accordance with manufacturer's written instructions.
1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
  2. Do not apply to concrete that is less than 28 days' old.
  3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing.
  4. Rinse with water; remove excess material until surface is dry.
  5. Apply a second coat in a similar manner if surface is rough or porous.
- B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller in accordance with manufacturer's written instructions.

### 3.15 JOINT FILLING

- A. Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.
1. Defer joint filling until concrete has aged at least one month.
  2. Do not fill joints until construction traffic has permanently ceased.



- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.
- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches (50 mm) deep in formed joints.
- D. Overfill joint, and trim joint filler flush with top of joint after hardening.

### 3.16 CONCRETE SURFACE REPAIRS

#### A. Defective Concrete:

- 1. Repair and patch defective areas when approved by Architect.
- 2. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

#### B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1-part portland cement to 2-1/2 parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.

#### C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

- 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension to solid concrete.
  - a. Limit cut depth to 3/4 inch (19 mm).
  - b. Make edges of cuts perpendicular to concrete surface.
  - c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
  - d. Fill and compact with patching mortar before bonding agent has dried.
  - e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
- 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.
  - a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
  - b. Compact mortar in place and strike off slightly higher than surrounding surface.
- 3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance as determined by Architect.

#### D. Repairing Unformed Surfaces:

- 1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.
  - a. Correct low and high areas.
  - b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
3. After concrete has cured at least 14 days, correct high areas by grinding.
4. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.
  - a. Finish repaired areas to blend into adjacent concrete.
5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.
  - a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
  - b. Feather edges to match adjacent floor elevations.
6. Correct other low areas scheduled to remain exposed with repair topping.
  - a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor elevations.
  - b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
7. Repair defective areas, except random cracks and single holes 1 inch (25 mm) or less in diameter, by cutting out and replacing with fresh concrete.
  - a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch (19-mm) clearance all around.
  - b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
  - c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
  - d. Place, compact, and finish to blend with adjacent finished concrete.
  - e. Cure in same manner as adjacent concrete.
8. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar.
  - a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
  - b. Dampen cleaned concrete surfaces and apply bonding agent.
  - c. Place patching mortar before bonding agent has dried.
  - d. Compact patching mortar and finish to match adjacent concrete.
  - e. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

### 3.17 FIELD QUALITY ASSURANCE

- A. Testing Agency: Department through the Professional to engage an independent qualified testing and inspecting agency to perform tests and inspections, including Special Inspections, and to submit reports.
1. Testing agency shall be responsible for providing curing container for composite samples on Site and verifying that field-cured composite samples are cured in accordance with ASTM C31/C31M.
  2. Testing agency shall immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
  3. Testing agency shall report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.
    - a. Test reports shall include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:
      - 1) Project name.
      - 2) Name of testing agency.
      - 3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
      - 4) Name of concrete manufacturer.
      - 5) Date and time of inspection, sampling, and field testing.
      - 6) Date and time of concrete placement.
      - 7) Location in Work of concrete represented by samples.
      - 8) Date and time sample was obtained.
      - 9) Truck and batch ticket numbers.
      - 10) Design compressive strength at 28 days.
      - 11) Concrete mixture designation, proportions, and materials.
      - 12) Field test results.
      - 13) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
      - 14) Type of fracture and compressive break strengths at seven days and 28 days.
- B. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.
- C. Inspections:
1. Headed bolts and studs.
  2. Steel-reinforcement placement.
  3. Steel reinforcement mechanical splice couplers.
  4. Steel-reinforcement welding.
  5. Verification of use of required design mixture.
  6. Concrete placement, including conveying and depositing.
  7. Curing procedures and maintenance of curing temperature.
  8. Verification of concrete strength before removal of shores and forms from beams and slabs.
  9. Batch Plant Inspections: On a random basis, as determined by Architect.

- D. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M shall be performed in accordance with the following requirements:
1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.
    - a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
  2. Slump: ASTM C143/C143M:
    - a. One test at point of placement for each composite sample. Test each truck load.
    - b. Perform additional tests when concrete consistency appears to change.
  3. Slump Flow: ASTM C1611/C1611M:
    - a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
    - b. Perform additional tests when concrete consistency appears to change.
  4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete; ASTM C173/C173M volumetric method, for structural lightweight concrete.
    - a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  5. Concrete Temperature: ASTM C1064/C1064M:
    - a. One test hourly when air temperature is 40 deg F (4.4 deg C) and below or 80 deg F (27 deg C) and above. At a minimum record temperature for each truck load.
  6. Unit Weight: ASTM C567/C567M fresh unit weight of structural lightweight concrete.
    - a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  7. Compression Test Specimens: ASTM C31/C31M:
    - a. Cast and laboratory cure three sets of two 6-inch (150 mm) by 12-inch (300 mm) or three 4-inch (100 mm) by 8-inch (200 mm) cylinder specimens for each composite sample.
    - b. Cast, initial cure, and field cure two sets of two 6-inch (150 mm) by 12-inch (300 mm) or three 4-inch (100 mm) by 8-inch (200 mm) cylinder specimens for each composite sample.
  8. Compressive-Strength Tests: ASTM C39/C39M.
    - a. Test one set of two 6-inch (150 mm) by 12-inch (300 mm) or three 4-inch (100 mm) by 8-inch (200 mm) laboratory-cured specimens at seven days and one set of specimens at 28 days.

- b. Retain one set of two 6-inch (150 mm) by 12-inch (300 mm) or three 4-inch (100 mm) by 8-inch (200 mm) laboratory-cured specimens for 56 days.
  - c. Test one set of two 6-inch (150 mm) by 12-inch (300 mm) or three 4-inch (100 mm) by 8-inch (200 mm) field-cured specimens at contractor's option of seven days or earlier and one set of specimens at 28 days.
  - d. A compressive-strength test shall be the average compressive strength from a set of specimens obtained from same composite sample and tested at age indicated.
9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
10. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa) if specified compressive strength is 5000 psi (34.5 MPa), or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi (34.5 MPa).
11. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
12. Additional Tests:
- a. Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
  - b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.
    - 1) Acceptance criteria for concrete strength shall be in accordance with ACI 301 (ACI 301M), section 1.6.6.3.
13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
15. If compressive strength of in situ concrete is accepted, either without additional testing or on the basis of testing other than original cylinder compressive strength tests, the Contractor shall compensate the Department for the Contractor's failure to meet specified strength requirements by paying to the Department one hundred dollars (\$100) per cubic yard for each on hundred pounds per square inch (100psi) below the specified compressive strength. The original laboratory cured 28-day cylinder compressive strength test results only shall be used to determine the difference between specified and furnished strengths.
- E. Measure floor and slab flatness and levelness in accordance with ASTM E1155 (ASTM E1155M) within 24 hours of completion of floor finishing and promptly report test results to Architect.

### 3.18 PROTECTION

- A. Protect concrete surfaces as follows:

1. Protect from petroleum stains.
2. Diaper hydraulic equipment used over concrete surfaces.
3. Prohibit vehicles from interior concrete slabs.
4. Prohibit use of pipe-cutting machinery over concrete surfaces.
5. Prohibit placement of steel items on concrete surfaces.
6. Prohibit use of acids or acidic detergents over concrete surfaces.
7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.
8. Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using Floor Slab Protective Covering.

END OF SECTION 033000

## SECTION 03 45 00

### PRECAST ARCHITECTURAL CONCRETE

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:

- 1. Architectural precast concrete site walls and seat wall.

- B. Related Requirements:

- 1. Section 03 30 00 "Cast-in-Place Concrete" for back-up walls.

- 2. Section 07 92 00 "Joint Sealants" for mortar and grout for joints.

##### 1.3 DEFINITIONS

- A. Design Reference Sample: Sample of approved architectural precast concrete color, finish and texture, preapproved by Architect.

##### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

- B. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors"

##### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Design Mixtures: For each precast concrete mixture. Include compressive strength and water-absorption tests.

- C. Shop Drawings:

- 1. Detail fabrication and installation of architectural precast concrete units.

2. Indicate locations, plans, elevations, dimensions, shapes, and cross sections of each unit.
  3. Indicate joints, reveals, drips, chamfers, and extent and location of each surface finish.
  4. Indicate details at wall corners.
  5. Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.
  6. Indicate relationship of architectural precast concrete units to adjacent materials.
  7. If design modifications are proposed to meet performance requirements and field conditions, submit design calculations and Shop Drawings. Do not adversely affect the appearance, durability, or strength of units when modifying details or materials and maintain the general design concept.
- D. Samples: Design reference samples for initial verification of design intent, for each type of finish indicated on exposed surfaces of architectural precast concrete units, in sets of three, representative of finish, color, and texture variations expected; approximately 12 by 12 by 2 inches. Color to match building precast / cementitious material.
1. Grout Samples for Initial Selection: Color charts consisting of actual sections of grout showing manufacturer's full range of colors.
  2. Grout Samples for Verification: Showing color and texture of joint treatment.
- 1.6 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For Installer and fabricator.
- B. Material Certificates: For the following items:
1. Cementitious materials.
  2. Reinforcing materials and prestressing tendons.
  3. Admixtures.
  4. Bearing pads.
- 1.7 QUALITY ASSURANCE
- A. Installer Qualifications: A precast concrete erector qualified and designated by PCI's Certificate of Compliance to erect Category A (Architectural Systems) for non-load-bearing members.
- B. Fabricator Qualifications: A firm that assumes responsibility for engineering architectural precast concrete units to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
- C. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 117, "Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products."
- D. Sample Panels/Sections: After sample approval and before fabricating architectural precast concrete units, produce a minimum of two full size sections for review by Architect. Incorporate full-scale details of architectural features, finishes, textures, and transitions in sample panels.
1. Locate panels where indicated or, if not indicated, as directed by Architect.
  2. Damage part of an exposed-face surface for each finish, color, and texture, and demonstrate adequacy of repair techniques proposed for repair of surface blemishes.



3. After acceptance of repair technique, maintain one sample panel at manufacturer's plant and one at Project site in an undisturbed condition as a standard for judging the completed Work.
4. Demolish and remove sample panels when directed.

## 1.8 COORDINATION

- A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction without delaying the Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver architectural precast concrete units in such quantities and at such times to limit unloading units temporarily on the ground or other rehandling.
- B. Support units during shipment on nonstaining shock-absorbing material.
- C. Store units with adequate dunnage and bracing and protect units to prevent contact with soil, to prevent staining, and to prevent cracking, distortion, warping or other physical damage.
- D. Place stored units so identification marks are clearly visible, and units can be inspected.
- E. Handle and transport units in a manner that avoids excessive stresses that cause cracking or damage.
- F. Lift and support units only at designated points indicated on Shop Drawings.

## PART 2 - PRODUCTS

### 2.1 MOLD MATERIALS

- A. Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that provides continuous and true precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required finishes.
  1. Mold-Release Agent: Commercially produced form-release agent that does not bond with, stain or adversely affect precast concrete surfaces and does not impair subsequent surface or joint treatments of precast concrete.

### 2.2 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
- C. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60, deformed bars, assembled with clips.

- D. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.
- E. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
- F. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 117.

## 2.3 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150/C 150M, Type I or Type III, white, unless otherwise indicated.
  - 1. For surfaces exposed to view in finished structure, use white cement, of same type, brand, and mill source.
- B. Supplementary Cementitious Materials: For use only if included in production of samples.
  - 1. Metakaolin: ASTM C 618, Class N.
  - 2. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- C. Normal-Weight Aggregates: Except as modified by PCI MNL 117, ASTM C 33/C 33M, with coarse aggregates complying with Class 5S. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.
- D. Lightweight Aggregates: Except as modified by PCI MNL 117, ASTM C 330/C 330M, with absorption less than 11 percent.
- E. Coloring Admixture: ASTM C 979/C 979M, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable, and nonfading.
- F. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 117.
- G. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
- H. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.
  - 1. Water-Reducing Admixtures: ASTM C 494/C 494M, Type A.
  - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
  - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
  - 4. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.
  - 5. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
  - 6. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
  - 7. Plasticizing Admixture: ASTM C 1017/C 1017M, Type I.
  - 8. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
  - 9. Corrosion Inhibiting Admixture: ASTM C 1582/C 1582M.

## 2.4 STAINLESS-STEEL CONNECTION MATERIALS

- A. Stainless-Steel Plate: ASTM A 666, Type 304, Type 316, or Type 201.

- B. Stainless-Steel Bolts and Studs: ASTM F 593, Alloy Group 1 or 2 hex-head bolts and studs; ASTM F 594, Alloy Group 1 or 2 stainless-steel nuts; and flat, stainless-steel washers.
  - 1. Lubricate threaded parts of stainless-steel bolts with an antiseize thread lubricant during assembly.
- C. Stainless-Steel-Headed Studs: ASTM A 276, Alloy 304 or Alloy 316, with minimum mechanical properties of PCI MNL 117, Table 3.2.3.

## 2.5 ACCESSORIES

- A. Precast Accessories: Provide clips, hangers, high-density plastic or steel shims, and other accessories required to install architectural precast concrete units.

## 2.6 GROUT MATERIALS

- A. Sand-Cement Grout: Portland cement, ASTM C 150/C 150M, Type I, and clean, natural sand, ASTM C 144 or ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 to 3 parts sand, by volume, with minimum water required for placement and hydration. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C 1218/C 1218M.
- B. Nonmetallic, Nonshrink Grout: Packaged, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107/C 1107M, Grade A for drypack and Grades B and C for flowable grout and of consistency suitable for application within a 30-minute working time. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C 1218/C 1218M.
- C. Epoxy-Resin Grout: Two-component, mineral-filled epoxy resin; ASTM C 881/C 881M, of type, grade, and class to suit requirements.

## 2.7 CONCRETE MIXTURES

- A. Prepare design mixtures for each type of precast concrete required.
  - 1. Use a single design mixture for units with more than one major face or edge exposed.
  - 2. Where only one face of unit is exposed use either a single design mixture or separate mixtures for face and backup.
- B. Limit use of fly ash and ground granulated blast-furnace slag to 20 percent of portland cement by weight; limit metakaolin and silica fume to 10 percent of portland cement by weight.
- C. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at architectural precast concrete fabricator's option.
- D. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 or PCI MNL 117 when tested according to ASTM C 1218/C 1218M.
- E. Normal-Weight Concrete Mixtures: Proportion face and backup mixtures or full-depth mixtures, at fabricator's option by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 5000 psi minimum.
  2. Maximum Water-Cementitious Materials Ratio: 0.45.
- F. Water Absorption: 6 percent by weight or 14 percent by volume, tested according to ASTM C 642, except for boiling requirement.
- G. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 117.
- H. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.

## 2.8 MOLD FABRICATION

- A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for prestressing and detensioning operations. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.
1. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and supports to maintain stability of liners during concrete placement. Coat form liner with form-release agent.
- B. Maintain molds to provide completed architectural precast concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.
1. Form joints are not permitted on faces exposed to view in the finished work.
  2. Edge and Corner Treatment: Uniformly chamfered.

## 2.9 FABRICATION

- A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.
- B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing architectural precast concrete units to supporting and adjacent construction.
- C. Reinforcement: Comply with recommendations in PCI MNL 117 for fabricating, placing, and supporting reinforcement.
1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy-coated reinforcing exceeds limits specified in ASTM A 775/A 775M, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.
  2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.

3. Place reinforcing steel and prestressing strands to maintain at least 3/4-inch minimum concrete cover. Increase cover requirements for reinforcing steel to 1-1/2 inches when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
  4. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.
- D. Reinforce architectural precast concrete units to resist handling, transportation, and erection stresses and specified in-place loads.
  - E. Comply with requirements in PCI MNL 117 and requirements in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.
  - F. Place face mixture to a minimum thickness after consolidation of the greater of 1 inch or 1.5 times the maximum aggregate size, but not less than the minimum reinforcing cover specified.
  - G. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete units.
    1. Place backup concrete mixture to ensure bond with face-mixture concrete.
  - H. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 117.
    1. Place self-consolidating concrete without vibration according to PCI TR-6, "Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants." Ensure adequate bond between face and backup concrete, if used.
  - I. Comply with PCI MNL 117 for hot- and cold-weather concrete placement.
  - J. Identify pickup points of architectural precast concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each architectural precast concrete unit on a surface that does not show in finished structure.
  - K. Cure concrete, according to requirements in PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.
  - L. Discard and replace architectural precast concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 117 and Architect's approval.
- 2.10 FABRICATION TOLERANCES
- A. Fabricate architectural precast concrete units to shapes, lines, and dimensions indicated so each finished unit complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.

## 2.11 FINISHES

- A. Exposed faces shall be free of joint marks, grain, and other obvious defects. Corners, including false joints shall be uniform, straight, and sharp. Finish exposed-face surfaces of architectural precast concrete units to match approved sample panels and as follows:
  - 1. As-Cast Surface Finish: Provide surfaces to match approved sample for acceptable surface, air voids, sand streaks, and honeycomb.
- B. Finish exposed top, end and back surfaces of architectural precast concrete units to match face-surface finish.
- C. Finish unexposed surfaces of architectural precast concrete units with as cast finish.
- D. Color: As selected by Architect from Manufacturers full color line.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, bearing surface tolerances, and other conditions affecting performance of the Work.
- B. Do not install precast concrete units until supporting cast-in-place concrete has attained minimum allowable design compressive strength and supporting steel or other structure is structurally ready to receive loads from precast concrete units.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install accessories required for connecting architectural precast concrete units to supporting members and backup materials.
- B. Erect architectural precast concrete level, plumb, and square within specified allowable tolerances. Provide temporary supports and bracing as required to maintain position, stability, and alignment of units until permanent connections are completed.
  - 1. Install temporary steel or plastic spacing shims as precast concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
  - 2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
  - 3. Remove projecting lifting devices and grout fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.
  - 4. Unless otherwise indicated, maintain uniform joint widths of 3/4 inch.
- C. Connect architectural precast concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.

### 3.3 ERECTION TOLERANCES

- A. Erect architectural precast concrete units level, plumb, square, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 117, Appendix I.

### 3.4 REPAIRS

- A. Repair architectural precast concrete units if permitted by Architect. Architect reserves the right to reject repaired units that do not comply with requirements.
- B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet
- C. Remove and replace damaged architectural precast concrete units when repairs do not comply with requirements.

### 3.5 CLEANING

- A. Clean surfaces of precast concrete units exposed to view.
- B. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.
- C. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.
  - 1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's recommendations. Protect other work from staining or damage due to cleaning operations.
  - 2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

**END OF SECTION 03 45 00**

## SECTION 03 54 16

### HYDRAULIC CEMENT UNDERLAYMENT

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section includes polymer-modified, self-leveling, hydraulic cement underlayment for application below interior floor coverings.

##### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
- B. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product, including the following:
  - 1. For priming coating, include a printed statement of VOC content in g/L.

##### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Manufacturer's written installation instructions for hydraulic cement underlayment.
- C. Minutes of preinstallation conference.

##### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Installer who is approved by manufacturer for application of underlayment products required for this Project.



## 1.7 FIELD CONDITIONS

- A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ventilation, ambient temperature and humidity, and other conditions affecting underlayment performance.
  - 1. Place hydraulic cement underlayments only when ambient temperature and temperature of substrates are between 50 and 80 deg F.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

### 2.2 HYDRAULIC CEMENT UNDERLAYMENTS

- A. Hydraulic Cement Underlayment: Polymer-modified, self-leveling, hydraulic cement product that can be applied in minimum uniform thickness of 1/4 inch and that can be feathered at edges to match adjacent floor elevations.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide ARDEX Engineered Cements; Ardex K 15 or comparable product by one of the following, or equal approved by the Professional:
    - a. ARDEX Engineered Cements.
    - b. BASF Construction Chemicals - Building Systems.
    - c. Bonsal American, an Oldcastle company.
    - d. CGM, Incorporated.
    - e. CMP Specialty Products, Inc.
    - f. Dayton Superior.
    - g. Euclid Chemical Company (The); an RPM company.
    - h. Hacker Industries, Inc.
    - i. L&M Construction Chemicals, Inc.
    - j. Lambert Corporation.
    - k. MAPEI Corporation.
    - l. Maxxon Corporation.
    - m. TEC; H.B. Fuller Construction Products Inc.
    - n. Teck Specialties.
    - o. United States Gypsum Company.
  - 2. Cement Binder: ASTM C 150/C 150M, portland cement, or hydraulic or blended hydraulic cement as defined by ASTM C 219.
  - 3. Compressive Strength: Not less than 4000 psi at 28 days when tested according to ASTM C 109/C 109M.
  - 4. Underlayment Additive: Resilient-emulsion product of underlayment manufacturer, formulated for use with underlayment when applied to substrate and conditions indicated.

- B. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch; or coarse sand as recommended by underlayment manufacturer.
  - 1. Provide aggregate when recommended in writing by underlayment manufacturer for underlayment thickness required.
- C. Water: Potable and at a temperature of not more than 70 deg F.
- D. Primer: Product of underlayment manufacturer recommended in writing for substrate, conditions, and application indicated.
  - 1. VOC Content: Provide primer with VOC content of 200 g/L or less.
  - 2. Low-Emitting Primer: Primers used on the interior of the building shall meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine substrates, with Installer present, for conditions affecting performance of the Work.
- B. Proceed with application only after unsatisfactory conditions have been corrected.

#### **3.2 PREPARATION**

- A. General: Prepare and clean substrate according to manufacturer's written instructions.
  - 1. Treat nonmoving substrate cracks according to manufacturer's written instructions to prevent cracks from telegraphing (reflecting) through underlayment.
  - 2. Fill substrate voids to prevent underlayment from leaking.
- B. Concrete Substrates: Mechanically remove, according to manufacturer's written instructions, laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants that might impair underlayment bond.
  - 1. Moisture Testing: Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates do not exceed a maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
- C. Nonporous Substrates: For ceramic tile, quarry tile, and terrazzo substrates, remove waxes, sealants, and other contaminants that might impair underlayment bond, and prepare surfaces according to manufacturer's written instructions.
- D. Adhesion Tests: After substrate preparation, test substrate for adhesion with underlayment according to manufacturer's written instructions.

#### **3.3 APPLICATION**

- A. General: Mix and apply underlayment components according to manufacturer's written instructions.

1. Close areas to traffic during underlayment application and for time period after application recommended in writing by manufacturer.
  2. Coordinate application of components to provide optimum adhesion to substrate and between coats.
  3. At substrate expansion, isolation, and other moving joints, allow joint of same width to continue through underlayment.
- B. Apply primer over prepared substrate at manufacturer's recommended spreading rate.
- C. Apply underlayment to produce uniform, level surface.
1. Feather edges to match adjacent floor elevations.
- D. Cure underlayment according to manufacturer's written instructions. Prevent contamination during application and curing processes.
- E. Do not install floor coverings over underlayment until after time period recommended in writing by underlayment manufacturer.
- F. Remove and replace underlayment areas that evidence lack of bond with substrate, including areas that emit a "hollow" sound when tapped.
- 3.4 PROTECTION
- A. Protect underlayment from concentrated and rolling loads for remainder of construction period.

**END OF SECTION 03 54 16**

## SECTION 04 20 00

### UNIT MASONRY

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

###### A. Section Includes:

1. Concrete masonry units (CMU's).
2. Concrete building brick.
3. Face brick.
4. Hollow brick.
5. Mortar and grout.
6. Steel reinforcing bars.
7. Masonry joint reinforcement.
8. Ties and anchors.
9. Embedded flashing.
10. Miscellaneous masonry accessories.
11. Cavity-wall insulation.

###### B. Related Requirements:

1. Section 03 30 00 "Cast-in-Place Concrete" for dovetail slots for masonry anchors.
2. Section 03 45 00 "Precast Architectural Concrete".
3. Section 05 50 00 "Metal Fabrications" for furnishing steel lintels and shelf angles for unit masonry.
4. Section 07 62 00 "Sheet Metal Flashing and Trim" for exposed sheet metal flashing.
5. Section 32 32 23 "Segmental Retaining Walls" for dry-laid, concrete unit retaining walls.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

###### B. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement."
3. Flexible Flashing: Detail flashings at window and door openings in exterior construction, including tie-in with air barriers.
4. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

- C. Samples for Verification: For each type and color of exposed masonry unit(s) and colored mortar.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
  - 1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.
- B. Qualification Data: For testing agency.
- C. Material Certificates: For each type and size of the following:
  - 1. Masonry units.
    - a. Include material test reports substantiating compliance with requirements.
    - b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
    - c. For exposed brick, include test report for efflorescence according to ASTM C 67.
  - 2. Cementitious materials. Include brand, type, and name of manufacturer.
  - 3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
  - 4. Grout mixes. Include description of type and proportions of ingredients.
  - 5. Reinforcing bars.
  - 6. Joint reinforcement.
  - 7. Anchors, ties, and metal accessories.
- D. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
  - 1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
  - 2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
- E. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.
- F. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

#### 1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

- B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.
- C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.
- D. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.
- E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
  - 1. Build mockup of typical wall area as shown on Drawings.
    - a. Include a sealant-filled joint at least 16 inches long in each mockup.
    - b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately 12 inches wide by 16 inches high.
    - c. Include through-wall flashing installed for a 24-inch length in corner of exterior wall mockup approximately 16 inches down from top of mockup, with a 12-inch length of flashing left exposed to view (omit masonry above half of flashing).
    - d. Include metal studs, sheathing, sheathing joint-and-penetration treatment, air barrier, veneer anchors, flashing, cavity drainage material, and weep holes in exterior masonry-veneer wall mockup.
  - 2. Clean exposed faces of mockups with masonry cleaner as indicated.
  - 3. Protect accepted mockups from the elements with weather-resistant membrane.
  - 4. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
    - a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
    - b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.
  - 5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
  - 6. Demolish and remove mockups, including footings, when directed by Architect unless otherwise indicated.
- F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Section 01 31 00 "Project Management and Coordination."
  - 1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

## 1.7 PROJECT CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
  - 1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.
  - 2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
  - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
  - 2. Protect sills, ledges, and projections from mortar droppings.
  - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
  - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
  - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

## PART 2 - PRODUCTS

### 2.1 MASONRY UNITS, GENERAL

- A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.
- B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

### 2.2 CONCRETE MASONRY UNITS

- A. Aggregates: Expanded slate aggregates conforming to ASTM C 331 and ASTM C 330 and aggregates meeting ASTM C 33.
  - 1. The use of coal ash aggregates/bottom ash, cinders, or similar waste products shall not be allowed. The use of fly ash contained within the cement paste may be used at the manufacturer's discretion.
- B. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
  - 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
  - 2. Provide square-edged units for outside corners unless otherwise indicated.
- C. CMUs: ASTM C 90.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by the Professional:
    - a. Boxley.
    - b. Ernest Maier Brick.
    - c. Parker Block.
  - 2. Density Classifications:
    - a. Normal weight, 125 lb/cu. ft. or more, unless otherwise indicated.
    - b. Lightweight, less than 105 lb/cu. ft., for fire-resistance ratings indicated.
  - 3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
- D. Concrete Building Brick: ASTM C 55.

### 2.3 BRICK

- A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:
  - 1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.



- B. Face Brick: Facing brick complying with ASTM C 216 or hollow brick complying with ASTM C 652, Class H40V (void areas between 25 and 40 percent of gross cross-sectional area).
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by the Professional:
    - a. Acme Brick Company.
    - b. Belden Brick Company (The).
    - c. Boral Bricks, Inc.
    - d. Endicott Clay Products Co.
    - e. General Shale Brick.
    - f. Glen-Gery Corporation.
    - g. Interstate Brick Co.; Division of Pacific Coast Building Products, Inc.
    - h. I-XL Industries Ltd.
    - i. Pine Hall Brick.
    - j. Redland Brick Inc.; Subsidiary of Belden Brick Company (The).
  2. Grade: MW or SW.
  3. Type: FBX or HBX.
  4. Initial Rate of Absorption: Less than 30 g/30 sq. in. per minute when tested per ASTM C 67.
  5. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
  6. Size (Actual Dimensions): 3-5/8 inches wide by 2-1/4 inches high by 7-5/8 inches long.

#### 2.4 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- D. Colored Cement Product: Packaged blend made from portland cement and hydrated lime and mortar pigments, all complying with specified requirements, and containing no other ingredients.
1. Colored Portland Cement-Lime Mix:
    - a. Products: Subject to compliance with requirements, provide one of the following, or equal approved by Professional:
      - 1) Essroc, Italcementi Group; Flamingo-Brixment Portland Cement and Lime Blends In Color.
      - 2) Lafarge North America Inc.; Eaglebond Portland & Lime.
      - 3) Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.
    - b. Color(s): As selected by Architect from manufacturer's full range.
- E. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
  2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
  3. White-Mortar Aggregates: Natural white sand or crushed white stone.
  4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- F. Aggregate for Grout: ASTM C 404.
- G. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by the Professional:
    - a. Euclid Chemical Company (The); Accelguard 80.
    - b. Grace Construction Products, W. R. Grace & Co. - Conn.; Morset.
    - c. Sonneborn Products, BASF Aktiengesellschaft; Trimix-NCA.
- H. Water: Potable.

## 2.5 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.
- B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.
1. Interior Walls: Hot-dip galvanized, carbon steel.
  2. Exterior Walls: Hot-dip galvanized, carbon steel.
  3. Wire Size for Side Rods: 0.148-inch, 9-gage diameter.
  4. Wire Size for Cross Rods: 0.148-inch, 9-gage diameter.
  5. Wire Size for Veneer Ties: 0.148-inch, 9-gage diameter.
  6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
  7. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.
- C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.
- D. Masonry Joint Reinforcement for Multiwythe Masonry:
1. Ladder type with 1 side rod at each face shell of hollow masonry units more than 4 inches wide, plus 1 side rod at each wythe of masonry 4 inches wide or less.
  2. Tab type, either ladder or truss design, with 1 side rod at each face shell of backing wythe and with rectangular tabs sized to extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face.
  3. Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches. Size ties to extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face.
- E. Masonry Joint Reinforcement for Veneers Anchored with Seismic Masonry-Veneer Anchors: Single 0.187-inch- diameter, hot-dip galvanized, carbon-steel continuous wire.

## 2.6 TIES AND ANCHORS

- A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.
1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.
- B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.
- C. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.075-inch- thick, 14-gage, steel sheet, galvanized after fabrication.
  2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.187-inch- standard diameter, hot-dip galvanized steel wire.
- D. Partition Top Anchors: 0.105-inch- thick, 12-gage, metal plate with 3/8-inch- diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.
- E. Rigid Anchors: Fabricate from steel bars 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins unless otherwise indicated.
1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M.
- F. Adjustable Masonry-Veneer Anchors:
1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:
    - a. Structural Performance Characteristics: Capable of withstanding a 100-lbf load in both tension and compression without deforming or developing play in excess of 0.05 inch.
  2. Fabricate sheet metal anchor sections and other sheet metal parts from 0.075-inch- thick, 14-gage, steel sheet, galvanized after fabrication.
  3. Wire Ties: Triangular-, rectangular-, or T-shaped wire ties fabricated from 0.187-inch-diameter standard, hot-dip galvanized-steel wire.
  4. Contractor's Option: Unless otherwise indicated, provide any of the following types of anchors:
  5. Screw-Attached, Masonry-Veneer Anchors: Units consisting of a wire tie and a metal anchor section.
    - a. Products: Subject to compliance with requirements, provide one of the following, or equal approved by the Professional:
      - 1) Heckmann Building Products Inc.; 315-D with 316.
      - 2) Hohmann & Barnard, Inc.; DW-10HS.
      - 3) Wire-Bond; 1004, Type III Screw On Veneer Anchor.

- b. Anchor Section: Sheet metal plate, 1-1/4 inches wide by 6 inches long, with screw holes top and bottom and with raised rib-stiffened strap, 5/8 inch wide by 3-5/8 inches long, stamped into center to provide a slot between strap and plate for inserting wire tie.
- 6. Screw-Attached, Masonry-Veneer Anchors: Units consisting of a wire tie and a metal anchor section.
  - a. Products: Subject to compliance with requirements, provide one of the following, or equal approved by the Professional:
    - 1) Heckmann Building Products Inc.; Pos-I-Tie Brick Veneer Anchoring System.
    - 2) Hohmann & Barnard, Inc.; 2-Seal-Tie.
    - 3) Wire-Bond; SureTie.
  - b. Anchor Section: Corrosion-resistant, self-drilling, eye-screw designed to receive wire tie. Eye-screw has spacer that seats directly against framing and is same thickness as sheathing and has gasketed, washer head that covers hole in sheathing.
- 7. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C 954 except manufactured with hex washer head and neoprene or EPDM washer, No. 10 diameter by length required to penetrate steel stud flange with not less than three exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours per ASTM B 117.
  - a. Products: Subject to compliance with requirements, provide one of the following, or equal approved by the Professional:
    - 1) Elco Construction Products; Dril-Flex Structural Fasteners with Stalgard finish.
    - 2) ITW Buildex; Maxiseal Integral Washer System with Climaseal finish.

## 2.7 MISCELLANEOUS ANCHORS

- A. Anchor Bolts: Headed or L-shaped steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

## 2.8 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing complying with Section 07 62 00 "Sheet Metal Flashing and Trim" and as follows:
  - 1. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch thick.
  - 2. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 feet. Provide splice plates at joints of formed, smooth metal flashing.
  - 3. Fabricate through-wall flashing with drip edge unless otherwise indicated. Fabricate by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.

## 2.9 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; formulated from neoprene.
- B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- D. Weep/Vent Products:
  - 1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe, in color selected from manufacturer's standard.
    - a. Products: Subject to compliance with requirements, provide one of the following, or equal approved by the Professional:
      - 1) Advanced Building Products Inc.; Mortar Maze Cell Vents.
      - 2) Dayton Superior Corporation, Dur-O-Wal Division; Cell Vents.
      - 3) Heckmann Building Products Inc.; No. 85 Cell Vent.
      - 4) Hohmann & Barnard, Inc.; #QV - Quadro-Vent.
      - 5) Wire-Bond; Cell Vent.
- E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
  - 1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by the Professional:
    - a. Advanced Building Products Inc.; Mortar Break.
    - b. Archovations, Inc.; CavClear Masonry Mat.
    - c. Dayton Superior Corporation, Dur-O-Wal Division; Polytite MortarStop.
    - d. Mortar Net USA, Ltd.; Mortar Net.
  - 2. Provide one of the following configurations:
    - a. Strips, full-depth of cavity and 10 inches high, with dovetail shaped notches 7 inches deep that prevent clogging with mortar droppings.
    - b. Strips, full depth of cavity and 10 inches high, with dimpled surface designed to catch mortar droppings and prevent weep holes from clogging with mortar.
- F. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
  - 1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by the Professional:
    - a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.
    - b. Heckmann Building Products Inc.; No. 376 Rebar Positioner.
    - c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.

- d. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner.

## 2.10 CAVITY-WALL INSULATION

- A. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, closed-cell product extruded with an integral skin.
- B. Adhesive: Type recommended by insulation board manufacturer for application indicated.

## 2.11 MASONRY CLEANERS

- A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by the Professional:
    - a. Diedrich Technologies, Inc.
    - b. EaCo Chem, Inc.
    - c. PROSOCO, Inc.

## 2.12 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
  - 1. Do not use calcium chloride in mortar or grout.
  - 2. Use portland cement-lime mortar unless otherwise indicated.
  - 3. For exterior masonry, use portland cement-lime mortar.
  - 4. For reinforced masonry, use portland cement-lime mortar.
  - 5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.
  - 1. For masonry below grade or in contact with earth, use Type M.
  - 2. For reinforced masonry, use Type S.
  - 3. For exterior, above-grade, load-bearing masonry walls, use Type S.
  - 4. For exterior, above-grade, veneer and non-load-bearing walls and parapet walls, use Type N.
  - 5. For interior non-load-bearing walls, use Type N.
  - 6. For interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.

- D. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
  - 1. Mix to match Architect's sample.
  - 2. Application: Use colored aggregate mortar for exposed mortar joints with the following units:
    - a. Face brick.
- E. Grout for Unit Masonry: Comply with ASTM C 476.
  - 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
  - 2. Proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.
  - 3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
  - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
  - 2. Verify that foundations are within tolerances specified.
  - 3. Verify that reinforcing dowels are properly placed.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 INSTALLATION, GENERAL**

- A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

1. Mix units from several pallets or cubes as they are placed.
- F. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

### 3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.



### 3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.
- G. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
  - 1. Install compressible filler in joint between top of partition and underside of structure above.
  - 2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors 48 inches o.c. unless otherwise indicated.
  - 3. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
  - 4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 07 84 46 "Fire-Resistive Joint Systems."

### 3.5 MORTAR BEDDING AND JOINTING

- A. Lay hollow CMUs as follows:
  - 1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
  - 2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
  - 3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
  - 4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

- B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
- D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

### 3.6 CAVITY WALLS

- A. Bond wythes of cavity walls together using one of the following methods:
  - 1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 1.77 sq. ft. of wall area spaced not to exceed 16 inches o.c. horizontally and 16 inches o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than 36 inches apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches o.c. vertically.
    - a. Where bed joints of wythes do not align, use adjustable (two-piece) type ties.
    - b. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type ties to allow for differential movement regardless of whether bed joints align.
  - 2. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
    - a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes.
    - b. Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement.
    - c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement to allow for differential movement regardless of whether bed joints align.
  - 3. Header Bonding: Provide masonry unit headers extending not less than 3 inches into each wythe. Space headers not over 8 inches clear horizontally and 16 inches clear vertically.
  - 4. Masonry Veneer Anchors: Comply with requirements for anchoring masonry veneers.
- B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.
- C. Apply air barrier to face of backup wythe to comply with Section 07 27 26 "Fluid-Applied Membrane Air Barriers."
- D. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.

1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

### 3.7 MASONRY JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
  1. Space reinforcement not more than 16 inches o.c.
  2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
  3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings.
- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.

### 3.8 ANCHORING MASONRY TO CONCRETE

- A. Anchor masonry to and concrete where masonry abuts or faces concrete to comply with the following:
  1. Provide an open space not less than 2 inches wide between masonry and concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
  2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
  3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

### 3.9 ANCHORING MASONRY VENEERS

- A. Anchor masonry veneers to wall framing and concrete and masonry backup with masonry-veneer anchors to comply with the following requirements:
  1. Fasten screw-attached anchors through sheathing to wall framing and to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
  2. Embed tie sections in masonry joints. Provide not less than 2 inches of air space between back of masonry veneer and face of sheathing.
  3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
  4. Space anchors as indicated, but not more than 16 inches o.c. vertically and 16 inches o.c. horizontally with not less than 1 anchor for each 1.77 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 36 inches, around perimeter.

### 3.10 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
  - 1. For CMU walls and partitions provide control joints per recommendations in NCMA TEK 10-1A, "Crack Control in Concrete Masonry Walls," and NCMA TEK 10-2C, "Control Joints for Concrete Masonry Walls - Empirical Method."
  - 2. For CMU veneers provide control joints per recommendations in NCMA TEK 10-4, "Crack Control for Concrete Brick and Other Concrete Masonry Veneers."
  - 3. For brick veneer provide expansion joints per recommendations in BIA Technical Note 18A, "Accommodating Expansion of Brickwork."
- B. Form control joints in concrete masonry using one of the following methods:
  - 1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
  - 2. Install preformed control-joint gaskets designed to fit standard sash block.
  - 3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
  - 4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.
- C. Form expansion joints in brick as follows:
  - 1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
  - 2. Build in compressible joint fillers where indicated.
  - 3. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Section 07 92 00 "Joint Sealants."
- D. Provide horizontal, pressure-relieving joints by inserting a compressible filler of width required for installing sealant and backer rod specified in Section 07 92 00 "Joint Sealants," but not less than 3/8 inch.
  - 1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

### 3.11 LINTELS

- A. Install steel lintels where indicated.
- B. Provide lintels where shown on Drawings and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.
- C. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

### 3.12 FLASHING, WEEP HOLES, AND CAVITY DRAINAGE, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated
- B. Install flashing as follows unless otherwise indicated:
  - 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
  - 2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 8 inches, and through inner wythe to within 1/2 inch of the interior face of wall in exposed masonry. Where interior face of wall is to receive furring or framing, carry flashing completely through inner wythe and turn flashing up approximately 2 inches on interior face.
  - 3. At masonry-veneer walls, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least 8 inches; with upper edge tucked under building paper or building wrap, lapping at least 4 inches.
  - 4. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
- C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.
- D. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
  - 1. Use specified weep/vent products to form weep holes.
  - 2. Space weep holes 24 inches o.c. unless otherwise indicated.
- E. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.
- F. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/vent products to form vents.
  - 1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

### 3.13 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
  - 1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.

2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
  2. Limit height of vertical grout pours to not more than 60 inches.
- 3.14 IDENTIFICATION OF INTERIOR FIRE- AND SMOKE-RATED WALLS AND PARTITIONS
- A. Markings and Identification: Refer to requirements specified in Section 09 91 23 "Interior Painting."
- 3.15 FIELD QUALITY CONTROL
- A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
- B. Inspections: Level 1 special inspections according to the "International Building Code."
1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
  2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
  3. Place grout only after inspectors have verified proportions of site-prepared grout.
  4. DGS REQUIREMENTS. As an alternative method of fulfilling the requirement in Chapter 17 - Special Inspections of the IBC for "continuous" inspection of grout placement in CMU cores, the specifications shall require that the Contractor mark in an approved manner the location of filled cores for the QA Agent to verify the presence of reinforcing steel using a rebar locator and the presence of grout using an ultrasound device.
- C. Testing Prior to Construction: One set of tests.
- D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.
- E. Clay Masonry Unit Test: For each type of unit provided, according to ASTM C 67 for compressive strength.
- F. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.
- G. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.
- H. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content.

- I. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

### 3.16 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
  - 1. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
  - 2. Protect adjacent surfaces from contact with cleaner.
  - 3. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
  - 4. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
  - 5. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

### 3.17 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
  - 1. Do not dispose of masonry waste as fill within 18 inches of finished grade.
- C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

**END OF SECTION 04 20 00**

SECTION 050519

POST-INSTALLED ANCHORS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" for a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

- A. Section includes drilled in anchors for concrete and masonry.
- B. Related Requirements:
  - 1. Section 033000 "Cast-in-place concrete."
  - 2. Section 041200 "Concrete Unit Masonry"
  - 3. Section 051200 for "Structural Steel."
  - 4. Division 8 for curtain wall support.
  - 5. Division 22, 23, and 26 Hangers and Supports Sections.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Product specifications shall include recommended design values and physical characteristics for epoxy dowels, expansion, and mechanical anchors.
- B. Post-Installed Anchor Product Data: Submit data for proprietary materials, ICC-ES reports, manufacturer's specifications (including finishes and/or materials), and Material Safety Data Sheets (MSDS).
  - 1. Submittals shall clearly indicate where each anchor type and diameter is intended to be used.
  - 2. ICC-ES listings and performance data shall include recommended loading for each application.
  - 3. ICC-ES certificates shall be valid for the design code of the project.
  - 4. Products other than "Basis of Design Anchors:"
    - a. Only manufacturers with an ICC-ES or IAPMO-UES listing will be considered for substitution requests.
    - b. The contractor shall submit, for Engineer-of-Record's review, calculations that are prepared & sealed by a registered Professional Engineer demonstrating that the substituted product is capable of achieving the pertinent equivalent performance values of the specified product using the appropriate design procedure and/or standard(s) as required by the Building Code.
    - c. In addition, the calculations shall specify the diameter and embedment depth of the substituted product.
    - d. Any increase in material costs for such submittal shall be the responsibility of the contractor.



#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Installer Qualifications & Procedures: Submit a letter of procedure stating method of drilling, the product proposed for use, the complete installation procedure, manufacturer training date, and a list of the personnel to be trained on anchor installation.
- C. Manufacturer's printed installation instructions (MPII).
- D. Field quality-control reports.
- E. Closeout Submittals: Submit the following:
  - 1. Record Documents: Project record documents for installed materials.

#### 1.5 QUALITY ASSURANCE

- A. Post-Installed Anchor Installer Qualifications: Post-installed anchors shall be installed by a qualified contractor/installer with at least three years of experience performing similar installations. Experience shall include installing anchors equal to type and into the substrate material required for this project. Installers shall undergo training as follows:
  - 1. Installer training: Conduct a thorough training with the manufacturer or the manufacturer's representative for the contractor/installer. Training to consist of a review of the complete installation process for drilled-in anchors, to include but not limited to:
    - a. Hole drilling procedure
    - b. Hole preparation and cleaning technique
    - c. Adhesive Injection & dispenser training and maintenance
    - d. Rebar dowel preparation and installation
    - e. Proof loading/torquing
- B. Installation of adhesive anchors shall only be performed by personal trained to install adhesive anchors. Installation of anchors shall be in accordance with the Manufacturer's Printed Installation Instructions (MPII).
- C. Certifications: Anchors shall have the following certification: ICC ES Evaluation Report indicating compliance with ICC ES Acceptance Criteria applicable for the governing building code.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver to job site in manufacturer's or distributor's packing undamaged, complete with installation instructions. Store anchors and adhesives in accordance with manufacturer's recommendations. Protect and handle materials in accordance with manufacturer's recommendations to prevent damage or deterioration.

#### 1.7 PROJECT CONDITIONS

- A. Adhesive anchors shall be installed in concrete having a minimum age of 21 days at the time of anchor installation.
- B. Anchoring adhesives must be stored at temperatures prescribed by the manufacturer.
- C. Anchoring adhesives must not be used beyond the expiration date.

- D. The anchor or fastener coating, plating, or steel type must provide suitable corrosion resistance for the environment for which the anchor or fastener is installed.

## 1.8 BASIS OF DESIGN ANCHORS

- A. The Basis of Design anchor designated on the Drawings has been selected based on the required design load capacity as compared to the Manufacturer's specific allowable load capacity for that specific product. Drawings indicate type of anchor, size and length of embedment based on the specific product indicated. Refer to Division 01 "Product Requirements." Comparable products shall be submitted for review and approval by the engineer prior to installation.

## PART 2 - PRODUCTS

### 2.1 FASTENERS AND ANCHORS:

- A. Bolts and Studs: ASTM A307; ASTM A449 where "high strength" is indicated on the Drawings.
- B. Carbon and Alloy Steel Nuts: ASTM A563.
- C. Carbon Steel Washers: ASTM F436.
- D. Carbon Steel Threaded Rod: ASTM A36; or ASTM A193 Grade B7; or ISO 898 Class 5.8.
- E. Wedge Anchors: ASTM A510; or ASTM A108.
- F. Stainless Steel Bolts, Hex Cap Screws, and Studs: ASTM F593.
- G. Stainless Steel Nuts: ASTM F594.
- H. Zinc Plating: ASTM B633.
- I. Hot-Dip Galvanizing: ASTM A153.
- J. Reinforcing Dowels: ASTM A615

### 2.2 DRILLED-IN ANCHORS FOR CONCRETE

- A. Anchors selected shall be ICC-ES approved for cracked concrete. Only anchors with ICBO/ICC approval are approved for use.
- B. Wedge anchors: Wedge type, torque-controlled, with impact section to prevent thread damage complete with required nuts and washers. Provide anchors with length identification markings conforming to ICC ES AC01 or ICC ES AC193. Type and size as indicated on Drawings.
  - 1. Interior use: Unless otherwise indicated on the Drawings, provide carbon steel anchors with zinc plating in accordance with ASTM B633, Type III Fe/Zn 5 (SC1).
  - 2. Exterior Use: Provide stainless steel anchors. Stainless steel anchors shall be AISI Type 304 and Type 316 stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener. Stainless steel

nuts shall conform to ASTM F594 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals. "Exterior" use conditions include but are not limited to the following:

- a. Exterior Exposed Conditions.
  - b. Interior spaces that are not conditioned (heated or cooled).
  - c. Potentially Wet Environments.
  - d. Attachment of Exterior Cladding Materials
3. Where anchor manufacturer is not indicated, subject to compliance with requirements and acceptance by the Engineer, provide the following:
- a. Hilti Kwik Bolt TZ (ICC-ES ESR-1917), carbon steel and AISI Type 304 Stainless Steel).
  - b. SIMPSON Strong-Tie Strong-Bolt 2 Wedge Anchor (ICC-ESR-3037), carbon steel or type 316 or 304 stainless steel)
  - c. DeWALT/POWERS – "Power-Stud + SD1"
  - d. DeWALT/POWERS – "Power Stud + SD2"
  - e. ITW/Redhead – Trubolt+ Wedge Anchor (ICC-ES ESR-2427)
- C. Screw Anchors: Screw type. Pre-drilling of the hole requires a standard ANSI drill bit with the same diameter as the anchor and installing the anchor will be done with an impact wrench. Provide anchors with a diameter and anchor length marking on the head. Type and size as indicated on Drawings.
1. Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel anchors with zinc plating equivalent to DIN EN ISO 4042 (8µm min.).
  2. Where anchor manufacturer is not indicated, subject to compliance with requirements and acceptance by the Engineer, provide the following:
    - a. Hilti Kwik-HUS-EZ (ICC-ES ESR-3027).
    - b. Hilti Kwik-HUS EZ-I (ICC-ES ESR-3027).
    - c. Hilti Kwik-HUS (ICC-ES ESR-3027).
    - d. Simpson Strong-Tie Titen HD Screw Anchor (ICC-ES ESR-2713).
    - e. DeWALT/POWERS Wedge-Bolt+ Screw Anchor (ICC-ES-ESR 1678)
    - f. DeWALT/POWERS Tapper+Screw Anchor (ICC-ES-ESR 3196)
- D. ITW Red Head Tapcon+ Screw anchor (ICC-ES ESR-3699). Cartridge Injection Adhesive Anchors: Threaded steel rod, inserts or reinforcing dowels, complete with nuts, washers, polymer or hybrid mortar adhesive injection system, and manufacturer's installation instructions. Type and size as indicated on Drawings. Drawing reference to "adhesive" associated with drilled rebar or "adhesive anchors" indicates use of this anchor type as specified by this paragraph.
1. Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel threaded rods conforming to ASTM A36, ASTM A 193 Type B7 or ISO 898 Class 5.8 with zinc plating in accordance with ASTM B633, Type III Fe/Zn 5 (SC1) [or carbon steel HIT TZ rods conforming to ASTM A510 with chemical composition of AISI 1038].
  2. Exterior Use: Provide stainless steel anchors. Stainless steel anchors shall be AISI Type 304 and Type 316 stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener. All nuts shall conform to ASTM F594 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals. "Exterior" use conditions include but are not limited to the following:

- a. Exterior Exposed Conditions.
  - b. Interior spaces that are not conditioned (heated or cooled).
  - c. Potentially Wet Environments.
  - d. Attachment of Exterior Cladding Materials
3. Reinforcing dowels shall be A615 Grade 60.
4. Where anchor manufacturer is not indicated, subject to compliance with requirements and acceptance by the Engineer, provide the following:
- a. Hilti HAS threaded rods with HIT-HY 200 Safe Set System using Hilti Hollow Drill Bit and VC 20/40 vacuum System for anchor and rebar anchorage to concrete, ICC ESR-3187.
  - b. Hilti HIT-Z anchor rods with HIT-HY 200 Safe Set System for anchorage to concrete, ICC ESR-3187.
  - c. Hilti HAS threaded rods with HIT-RE 500 V3 Safe Set System using Hilti Hollow Drill Bit and VC 20/40 vacuum System for anchor and rebar anchorage to concrete, ICC ESR-3814.
  - d. SIMPSON Strong-Tie Anchor Systems – “SET-XP Epoxy Adhesive Anchors”, ICC-ES ESR-2508
  - e. DeWALT/POWERS – AC 100+ GOLD (ICC-ES ESR-3200)
  - f. ITW Red Head – Epcon C6+ Adhesive Anchoring System (ICC-ES ESR-3577)

## 2.3 ANCHORAGE TO MASONRY

- A. Wedge anchors: Wedge type, torque-controlled, with impact section to prevent thread damage complete with required nuts and washers. Provide anchors with length identification markings conforming to ICC ES AC01 or ICC ES AC193. Type and size as indicated on Drawings.
- 1. Wedge type anchors are permissible at solid grouted masonry only. The Contractor shall ensure that the cores are grouted solid 24” deep minimum at locations where post installed anchors are required in solid grouted masonry. Contractor shall coordinate with all trades.
  - 2. Interior use: Unless otherwise indicated on the Drawings, provide carbon steel anchors with zinc plating in accordance with ASTM B633, Type III Fe/Zn 5 (SC1).
  - 3. Exterior Use: Provide stainless steel anchors. Stainless steel anchors shall be AISI Type 304 and Type 316 stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener. Stainless steel nuts shall conform to ASTM F594 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals. “Exterior” use conditions include but are not limited to the following:
    - a. Exterior Exposed Conditions.
    - b. Interior spaces that are not conditioned (heated or cooled).
    - c. Potentially Wet Environments.
    - d. Attachment of Exterior Cladding Materials
  - 4. Where anchor manufacturer is not indicated, subject to compliance with requirements and acceptance by the Engineer, provide the following:
    - a. Hilti Kwik Bolt 3 Expansion anchor
    - b. Simpson Strong-Tie Wedge-All Anchor, ICC-ES ESR-1396

- c. Dewalt/Powers Power-Stud+SD1 (ICC-ES ESR 2966)
- B. Cartridge Injection Adhesive Anchors: Threaded steel rod, inserts or reinforcing dowels, complete with nuts, washers, polymer or hybrid mortar adhesive injection system, and manufacturer's installation instructions. Type and size as indicated on Drawings.
- 1. Adhesive type anchors are permissible at both solid grouted and hollow masonry.
  - 2. Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel threaded rods conforming to ASTM A36, ASTM A 193 Type B7 or ISO 898 Class 5.8 with zinc plating in accordance with ASTM B633, Type III Fe/Zn 5 (SC1) [or carbon steel HIT TZ rods conforming to ASTM A510 with chemical composition of AISI 1038].
  - 3. Exterior Use: Provide stainless steel anchors. Stainless steel anchors shall be AISI Type 304 and Type 316 stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener. All nuts shall conform to ASTM F594 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals. "Exterior" use conditions include but are not limited to the following:
    - a. Exterior Exposed Conditions.
    - b. Interior spaces that are not conditioned (heated or cooled).
    - c. Potentially Wet Environments.
    - d. Attachment of Exterior Cladding Materials
  - 4. Reinforcing dowels shall be A615 Grade 60.
  - 5. Where anchor manufacturer is not indicated, subject to compliance with requirements and acceptance by the Engineer, provide the following:
    - a. Solid Grouted Masonry:
      - 1) Hilti HIT-HY 70 Masonry Adhesive Anchoring System. Steel rod element shall be Hilti HAS-E continuously threaded rod or deformed steel rebar.
      - 2) Simpson Strong-Tie SET-XP Epoxy Adhesive
      - 3) Dewalt/powers AC 100+ Gold
    - b. Hollow/Multi-Wythe Masonry:
      - 1) Hilti HIT-HY 70 Masonry Adhesive Anchoring System. Steel rod element shall be Hilti HAS-E continuously threaded rod or deformed steel rebar. The appropriate size screen shall be used per the adhesive manufacturer's recommendation.
      - 2) Simpson Strong-Tie SET-XP Epoxy Adhesive with stainless steel or plastic steel tube.
      - 3) Dewalt/powers AC 100+ Gold

## PART 3 - EXECUTION

### 3.1 INSTALLATION

#### A. Drilled-in anchors and rebar:

- 1. Drill holes with rotary impact hammer drills using carbide-tipped bits, hollow drill bit system, and/or core drills using diamond core bits. Drill bits shall be of diameters as

specified by the anchor manufacturer. Unless otherwise shown on the Drawings, all holes shall be drilled perpendicular to the concrete surface.

- a. Cored Holes: Where anchors are permitted to be installed in cored holes, use core bits with matched tolerances as specified by the manufacturer. Properly clean cored hole per manufacturer's instructions.
  - b. Embedded Items: Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Exercise care in coring or drilling to avoid damaging existing reinforcing or embedded items. Notify the Engineer if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and telecommunications conduit, and gas lines.
  - c. Base Material Strength: Unless otherwise specified, do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
2. Perform anchor installation in accordance with manufacturer instructions.
  3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in part to be fastened. Set anchors to manufacturer's recommended torque, using a torque wrench. Following attainment of 10% of the specified torque, 100% of the specified torque shall be reached within 7 or fewer complete turns of the nut. If the specified torque is not achieved within the required number of turns, the anchor shall be removed and replaced unless otherwise directed by the Engineer.
  4. Cartridge Injection Adhesive Anchors: Clean all holes per manufacturer instructions to remove loose material and drilling dust prior to installation of adhesive. Inject adhesive into holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive. Follow manufacturer recommendations to ensure proper mixing of adhesive components. Sufficient adhesive shall be injected in the hole to ensure that the annular gap is filled to the surface. Remove excess adhesive from the surface. Shim anchors with suitable device to center the anchor in the hole. Do not disturb or load anchors before manufacturer specified cure time has elapsed.
  5. Observe manufacturer recommendations with respect to installation temperatures for cartridge injection adhesive anchors and capsule anchors.
  6. Do not disturb or load anchor before manufacturer's specified curing time.

### 3.2 REPAIR OF DEFECTIVE WORK

- A. Remove and replace misplaced or malfunctioning anchors. Fill empty anchor holes and patch failed anchor locations with high-strength non-shrink, nonmetallic grout. Anchors that fail to meet proof load or installation torque requirements shall be regarded as malfunctioning.

### 3.3 FIELD QUALITY ASSURANCE

- A. Testing Agency: Department through the Professional to engage an independent qualified testing and inspecting agency to perform tests and inspections, including Special Inspections, and to submit reports.
- B. Special Inspection Requirements:

1. Special inspection is defined in ACI 318 as a function performed by qualified special inspectors in the employ of the owner or the owner's agent. Inspection is particularly important for post-installed anchors to make certain that the Manufacturer's Printed Installation Instructions (MPII) are followed. A distinction is made between continuous special inspection and periodic special inspection. Special Inspection, continuous or periodic, of post-installed anchors, shall be provided as required by ICC-ES or IAPMO-UES evaluation reports and/or as specified by the Engineer of Record. This service shall be performed by personnel independent of the manufacturer or contractor so as to prevent a conflict of interest.
2. As a minimum, the special inspector shall verify the following items:
  - a. Hole drilling method in accordance with the MPII.
  - b. Anchor edge distance and spacing.
  - c. Hole diameter and depth.
  - d. Hole cleaning in accordance with the MPII.
  - e. Anchor element type, material, diameter, and length.
  - f. Adhesive identification and expiration date.
  - g. Adhesive installation in accordance with the MPII
3. Continuous special inspection: Special inspector shall observe all aspects of anchor installation with the exception of holes drilled in the absence of the special inspector, provided the specific inspector examines the drill bits used for drilling and verifies the hole sizes.
4. Periodic special inspection: Special inspector shall verify the initial installation instruction of each type and size of adhesive anchor by construction personnel. Subsequent installation of the same anchor type and size by the same construction personal shall be permitted to be performed in the absence of the special inspector. Any change in in the anchor product being installed or the personnel performing the installation shall require an initial inspection. For ongoing installations over an extended period, the special inspector shall make regular inspections to confirm correct handling and installation of product
5. For mechanical anchors qualified for use in concrete in accordance with ICC-ES AC193, periodic special inspection is required.
6. For adhesive anchors qualified for use in concrete in accordance with ICC-ES AC308, installations may be made under continuous special inspection with an onsite proof loading program or periodic special inspection, as determined by the registered design professional. Strength reduction factors,  $\Phi$ , and additional factors published in the evaluation report, and used in design, must correspond to the type of inspection provided.
7. For adhesive anchors qualified for use in concrete in accordance with ICC-ES AC308, where required, a program for on-site proof loading, that is, proof loading program, to be conducted as part of the special inspection shall be established by the engineer or design professional of record and shall conform to the following minimum requirements:
  - a. Frequency of proof loading based on anchor type, diameter, and embedment.
  - b. Proof loads by anchor type, diameter, embedment, and location
  - c. Acceptable displacements at proof load
  - d. Remedial action in the event of failure to achieve proof load or excessive displacement

C. Proof Loads

1. Unless otherwise directed by the engineer or design professional of record, proof loads shall be applied as confined tension tests.
2. Proof load levels shall not exceed the lesser of 50 percent of the expected peak load based on adhesive bond strength or 80 percent of the anchor yield strength. Maintain the proof load at the required load level for a minimum of 10 seconds.

D. Torques

1. Torque test shall be in accordance with ACI 355.4. The torque testing shall achieve a torque resistance of at least  $1.3 \cdot T_{inst}$ . The anchor shall not turn in the anchor hole prior to reaching a torque resistance of  $1.3 \cdot T_{inst}$ .  $T_{inst}$  is per the manufacturer's product data.
- E. Testing:
1. In-service testing shall comply with ACI 355.4 Chapter 8.
  2. Periodic inspection shall be done at anchors not subject to continuous inspection requirements as follows:
    - a. 25% of each type and size of drilled-in anchor shall be proof loaded by the independent testing laboratory. Adhesive anchors and capsule anchors shall not be torque tested unless otherwise directed by the Engineer.
  3. Continuous inspection is required for the following cases:
    - a. Tension load applications.
    - b. Anchors installed horizontally or upwardly inclined orientations.
    - c. Seismic applications. Unless otherwise noted seismic applications are those in buildings with Seismic Design Category C, D, E, or F.
  4. If any of the tested anchors fail to achieve the specified torque or proof load within the limits as defined on the Drawings, all anchors of the same diameter and type as the failed anchor shall be tested, unless otherwise instructed by the Engineer.
  5. Tension testing should be performed in accordance with ASTM E488.
  6. Torque shall be applied with a calibrated torque wrench.
  7. Proof loads shall be applied with a calibrated hydraulic ram. Displacement of adhesive and capsule anchors at proof load shall not exceed  $D/10$ , where D is the nominal anchor diameter.
- F. Adhesive anchors installed in horizontal or upwardly inclined orientations to resist sustained tension loads shall be continuously inspected during installation by an inspector specially approved for that purpose by the building official. The special inspector shall furnish a report to the licensed design professional and building official that the work covered by the report has been performed and that the materials used and the installation procedures used conform with the approved contract documents and the manufacturer's printed installation instructions.
- G. Installation of adhesive anchors horizontally or upwardly inclined to support sustained tension loads shall be performed by personnel certified by an applicable certification program. Certification shall include written and performance tests in accordance with the ACI/CRSI Adhesive Anchor Installer Certification program, or equivalent.
- H. Minimum anchor embedment and design loads shall be as shown on the Drawings.

END OF SECTION 050519



## SECTION 051200

### STRUCTURAL STEEL FRAMING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" for a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

###### A. Section Includes:

1. Structural steel.
2. Field-installed shear connectors.
3. Grout.

###### B. Related Requirements:

1. Section 053100 "Steel Decking" for field installation of shear connectors through deck.
2. Section 055000 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame, miscellaneous steel fabrications, and other steel items not defined as structural steel.
3. Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for surface-preparation and priming requirements.
4. Division 050519 for post installed anchors.
5. Division 033000 for structural polystyrene insulation.

##### 1.3 DEFINITIONS

- A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
- B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.
- C. Heavy Sections: Rolled and built-up sections as follows:
  1. Shapes included in ASTM A 6/A 6M with flanges thicker than 1-1/2 inches (38 mm).
  2. Welded built-up members with plates thicker than 2 inches (50 mm).
  3. Column base plates thicker than 2 inches (50 mm).

#### 1.4 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

#### 1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.

#### 1.6 ACTION SUBMITTALS

- A. General:
  - 1. Submittals and shop drawings shall not be made by using reproductions of Contract Drawings.
  - 2. Submittals and shop drawings shall be submitted through General Contractor to Architect. Any fabrication of material before approval of drawings will be at the risk of Contractor.
    - a. Fabricated material and connections shall fit within architectural constraints.
    - a. Fabricator alone shall be responsible for errors of detailing and fabrication.
  - 3. Contractor shall provide a proposed submittal schedule showing anticipated steel shop drawing submission dates a minimum of two (2) weeks prior to the first steel shop drawing submittal.
  - 4. Steel submissions shall be submitted such that each individual construction sequence is a separate stand alone submittal package with an Erection Plan, Assembly Drawings, and Piece Mark Drawings. Typical Details, Connections, Calculations and Sections may be submitted as one submittal package at Contractors option, but must be received prior to the first sequence submission. Sequence submittals shall be submitted in the order that they will be Fabricated and Erected. Processing time for review of each sequence shall be allowed and shall not be assumed to be concurrent.
  - 5. Sequences larger than the floor area of the largest single floor of the building will require additional review and processing time. Additional review and processing time shall not be assumed to be concurrent. Any sequence anticipated to be larger than the maximum single floor area shall be clearly indicated in the submittal schedule and brought to the Architect's/Engineer's attention for discussion of review times prior to submission of said sequence.
- B. Product Data: For each type
- C. Product Data: For each type of product.
- D. Shop Drawings: Show fabrication of structural-steel components. Submit in advance of fabrication complete shop drawings prepared under the supervision of fabricator's registered professional Engineer for fabrication of each component part of structural steel framing.
  - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.

2. Include embedment Drawings.
  3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
  4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
  5. Identify members and connections of the Seismic-Load-Resisting System.
  6. Include member sizes.
  7. Include material specifications.
  8. Indicate piece marks for field assembly.
- E. Erection Drawings: Submit erection drawings ("E" Sheets) as part of shop drawings, showing complete information necessary for erection of each component part of structural steel framing.
1. Indicate setting drawings, templates and directions for installation of anchor rods and other anchorage devices embedded in concrete or masonry work.
  2. Indicate dimensions for alignment and elevation of each member.
  3. Indicate location of members and attachments by match-marking of piece members.
  4. Indicate piece marks for field assembly.
  5. Include type and location of each field connection, including splices.
  6. Indicate required number and location of shear connectors on each member.
  7. Indicate details of each field connection or typical connection.
  8. Indicate size, length and type of bolts required in each field connection.
- F. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing, including the following:
1. Power source (constant current or constant voltage).
  2. Electrode manufacturer and trade name, for demand critical welds.
- G. Delegated-Design Submittal: For structural-steel connections indicated to comply with design loads, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Submit in advance of steel shop drawings. All connections shall be designed by the fabricator's engineer per AISC 303 section 3.1.2 Option 3.
1. Proposed variations in typical details shown on drawings will be considered and such variations must have preliminary approval prior to preparation of detailed shop drawings.
  2. Connection drawings and details shall be prepared under supervision and sealed by a professional Engineer Registered in State of the project. Fabricator shall submit certification by professional Engineer that connection design is in accordance with applicable codes and specifications.
  3. Fabricator's engineer shall submit complete design calculations for each connection. Such calculations shall show details of assembled joint with bolts and welds required. Where predesigned connections are taken directly from tables in AISC Manual, calculations need not be submitted provided job design conditions precisely match those assumed in tables, data taken from tables is clearly identified with table number, and such connections are so indicated in calculations submitted. Design calculations shall be sealed by fabricator's registered professional engineer. Shop drawings submitted without complete design calculations will not be approved.
- H. Certificate of Conformance: Submit manufacturer's certificate of conformance and/or supporting Charpy V-Notch test reports for complete-joint-penetration weld filler metal where steel backer bars for CJP groove welded T and corner joints are elected by the Contractor to remain in

place. Certificate of Conformance or test reports shall show filler metal has a specified Charpy V-Notch toughness of 20 ft-lbs at 40 degrees F.

#### 1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, fabricator, shop-painting applicators, professional engineer, and testing agency.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- D. Mill test reports for structural steel, including chemical and physical properties.
- E. Product Test Reports: For the following:
  - 1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
  - 2. Direct-tension indicators.
  - 3. Tension-control, high-strength, bolt-nut-washer assemblies.
  - 4. Shear stud connectors.
  - 5. Shop primers.
  - 6. Nonshrink grout.
- F. Survey of existing conditions.
- G. Source quality-control reports.
- H. Field quality-control and special inspection reports.

#### 1.8 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU.
- B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.
- C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1 or to SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."
- D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  - 1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.
- E. Comply with applicable provisions of the following specifications and documents:

1. AISC 303.
  - a. Section 3.1.2 and Section 3.3 is hereby modified by deletion of the "Commentary."
  - b. Section 3.3 is hereby modified by deletion as follows: "When discrepancies exist between structural Design Drawings and the architectural, electrical, or mechanical Design Drawings or Design Drawings for other trades, the structural Design Drawings shall govern."
2. AISC 341 and AISC 341s1.
3. AISC 360.
4. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the site at such intervals to ensure uninterrupted progress of work.
- B. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
  1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
- C. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
  1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
  2. Clean and relubricate bolts and nuts that become dry or rusty before use.
  3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Connections: Provide details of all connections required by the Contract Documents to be selected or completed by structural-steel fabricator, including comprehensive engineering analysis by a qualified professional engineer, to withstand loads indicated and comply with other information and restrictions indicated.
  1. Select and complete connections using schematic details indicated and AISC 360.
  2. Use Allowable Stress Design; data are given at service-load level.

### 2.2 STRUCTURAL-STEEL MATERIALS

- A. General: All structural steel materials to be domestically manufactured in the United States of America.
- B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

- C. See General Notes for Structural Steel ASTM designations and grades, u.n.o.
- D. Steel Castings: ASTM A 216/A 216M, Grade WCB with supplementary requirement S11.
- E. Steel Forgings: ASTM A 668/A 668M.
- F. Welding Electrodes: Comply with AWS requirements.

## 2.3 BOLTS, CONNECTORS, AND ANCHORS

- A. General:
  - 1. Bolts, connectors, and anchors shall be new and not be reused.
- B. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325 (Grade A325M), Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH (ASTM A563M, Class 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
  - 1. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with plain finish.
- C. High-Strength A490 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A490 (Grade A490M), Type 1, heavy-hex steel structural bolts or Grade F2280 tension-control, bolt-nut-washer assemblies with splined ends; ASTM A563, Grade DH (ASTM A563M, Class 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
  - 1. Direct-Tension Indicators: ASTM F 959, Type 490 (ASTM F 959M, Type 10.9), compressible-washer type with plain finish.
- D. Zinc-Coated High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325 (Grade A325M), Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH (ASTM A563M, Class 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.
  - 1. Finish: Hot-dip zinc coating.
  - 2. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with mechanically deposited zinc coating, baked epoxy-coated finish.
- E. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125, Grade F1852, Type 1, heavy-hex head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
  - 1. Finish: Plain typical. Mechanically deposited zinc coating at exposed steel.
- F. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
- G. Headed Anchor Rods: See general notes for grades. Rods shall be straight.
  - 1. Nuts: ASTM A 563 (ASTM A 563M) heavy-hex carbon steel.
  - 2. Plate Washers: ASTM A 36/A 36M carbon steel.

3. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
4. Finish: Plain.

H. Threaded Rods: See general notes for grades.

1. Nuts: ASTM A 563 (ASTM A 563M) heavy-hex carbon steel.
2. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
3. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C or mechanically deposited zinc coating, ASTM B 695, Class 50.

I. Clevises and Turnbuckles: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1035.

J. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.

K. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1018.

L. Structural Slide Bearings: Low-friction assemblies, of configuration indicated, that provide vertical transfer of loads and allow horizontal movement perpendicular to plane of expansion joint while resisting movement within plane of expansion joint.

1. Mating Surfaces: PTFE and PTFE.
2. Coefficient of Friction: Not more than 0.06.
3. Design Load: Not less than 2,000 psi (13.7 MPa).
4. Total Movement Capability: 2 inches (50 mm).

## 2.4 PRIMER

- A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
- B. Galvanizing Repair Paint: ASTM A 780/A 780M.

## 2.5 GROUT

- A. Metallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.
  1. Non-metallic grout shall be used in all conditions unless noted otherwise.
  2. Compressive strength at 7 days: 6000 psi minimum.
  3. Compressive strength at 28 days: 8000 psi minimum.
- B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

## 2.6 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," and to AISC 360.

1. Camber structural-steel members where indicated.
2. Fabricate beams with rolling camber up.
3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
4. Mark and match-mark materials for field assembly.
5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 3, "Power Tool Cleaning."

F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

G. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural-steel frame. Straighten as required to provide uniform, square, and true members in completed wall framing. Build up welded framing, weld exposed joints continuously, and grind smooth.

H. Welded Door Frames: Build up welded door frames attached to structural-steel frame. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than 10 inches (250 mm) o.c. unless otherwise indicated.

I. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

## 2.7 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.



- B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
  - 1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

## 2.8 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
  - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
  - 2. Surfaces to be field welded.
  - 3. Surfaces of high-strength bolted, slip-critical connections.
  - 4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
  - 5. Galvanized surfaces.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
  - 1. SSPC-SP 2, "Hand Tool Cleaning."
  - 2. SSPC-SP 3, "Power Tool Cleaning."
  - 3. SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
  - 4. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."
  - 5. SSPC-SP 14/NACE No. 8, "Industrial Blast Cleaning."
  - 6. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - 7. SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning."
  - 8. SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning."
  - 9. SSPC-SP 8, "Pickling."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
  - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
  - 2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.
- D. Painting: Prepare steel and apply a one-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils (0.038 mm).

## 2.9 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.
  - 1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.

2. Galvanize lintels, shelf angles, and welded door frames attached to structural-steel frame and located in exterior walls.
3. Galvanize all steel exposed to weather, u.n.o.

## 2.10 SOURCE QUALITY CONTROL

- A. Testing Agency: Contractor to engage an independent qualified testing and inspection agency to perform tests and inspection, including Special Inspections, and to submit reports.
  1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. Bolted Connections: Inspect and test shop-bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- C. Welded Connections: Visually inspect shop-welded connections according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
  1. Liquid Penetrant Inspection: ASTM E 165.
  2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
  3. Ultrasonic Inspection: ASTM E 164.
  4. Radiographic Inspection: ASTM E 94.
- D. Full Penetration Welded Connections: In addition to visual inspection, complete joint penetration groove welds shall be ultrasonically tested for the entire weld length, in each designated joint per AWS D1.1 to the following extents:
  1. 100 percent of welds splicing beams, girders, columns, or braces.
  2. 100 percent of column to base plate welds at rigid (lateral) column frame bases.
  3. 100 percent of CJP beam to column welds, continuity plate welds, and shear tabs.
- E. Non-Destructive Testing of Welds:
  1. Ultrasonic Testing (UT): ASTM E164
    - a. Divide connections into groups containing not less than 40 connections. Test 25 percent of the connections in each group. If any weld is rejected, test all the connections in group.
- F. In addition to visual inspection, perform magnetic particle testing for full length of fillet welds on continuity plates and backing bar removal areas, and 25% of remaining fillet welds.
- G. In addition to visual inspection, test and inspect shop-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
  1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
  2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.
- H. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
  - 1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.
  - 1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

### 3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
- B. Baseplates, bearing plates, and leveling plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
  - 1. Set plates for structural members on wedges, shims, or setting nuts as required.
  - 2. Weld plate washers to top of baseplate.
  - 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
  - 4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- C. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
  - 1. Level and plumb individual members of structure.

2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Do not use thermal cutting during erection.
- G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

### 3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
  1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
  1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
  2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth. Backing bars MUST be removed if the project is in Seismic Design Category C and D. Contractor may elect to leave backing bars in place for all other projects if all following requirements are met:
    - a. Manufacturer shall submit a Certificate of Conformance and supporting Charpy V-Notch test reports showing filler metal used for backing bars has a toughness of 20 ft-lbs at 40 degrees F.
    - b. Certificate shall be received by the Engineer prior to the start of steel erection.
  3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," for mill material.

### 3.5 FIELD QUALITY ASSURANCE

- A. Special Inspections: Department through the Professional to Engage a qualified special inspector to perform the following special inspections, and as required by the International Building Code:
  1. Verify structural-steel materials and inspect steel frame joint details.
  2. Verify weld materials and inspect welds.
  3. Verify connection materials and inspect high-strength bolted connections.
  4. Verify location and setting of anchor rods by witness of Contractor's final check prior to setting of steel members.
  5. Verify plumbness of columns is within allowable tolerance per AISC Code and Commentary.

6. Verify that bracing and guying/cables, if required to secure framing during erection, are installed.
- B. Bolted Connections: Inspect and test bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
1. Minimum inspection requirements using the stated publication are as follows:
    - a. All bolts indicated to be "slip-critical" shall be inspected.
    - b. Two bolts in each bearing type bolted connection between girders and columns shall be inspected.
    - c. 10 percent of the remaining bolts, but not less than 2 in each connection shall be inspected.
  2. Bolts that fail shall be retightened and all remaining bolts in the connection shall be retested. Costs of retests on connections that fail shall be the Contractor's responsibility.
- C. Welded Connections: Visually inspect field welds according to AWS D1.1/D1.1M.
1. In addition to visual inspection, test and inspect field welds according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
    - a. Liquid Penetrant Inspection: ASTM E 165.
    - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
    - c. Ultrasonic Inspection: ASTM E 164.
    - d. Radiographic Inspection: ASTM E 94.
  2. In addition to visual inspection, 100 percent of full-penetration, moment connection field welds shall be ultrasonically tested according to AWS D1.1.
  3. Column splice welds shall be inspected by ultrasonic testing per AWS D1.1 to the following extent:
    - a. Rigid (Lateral) Columns: 100% of splice welds at each level shall be tested.
    - b. Non-Frame Columns: 25% of splice welds at each level shall be tested.
  4. Non-Destructive Testing of Remaining Welds:
    - a. Ultrasonic Testing (UT): ASTM E164
      - 1) Divide connections into groups containing not less than 40 connections. Test 25 percent of the connections in each group. If any weld is rejected, test all the connections in group.
  5. Extent of testing procedure shall be the entire weld length in each designated joint.
  6. Welds found unacceptable shall be repaired by methods permitted in AWS code and be retested. Costs of repair and additional testing shall be the Contractor's responsibility.
- D. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
  2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

### 3.6 REPAIRS AND PROTECTION

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780/A 780M.

- B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
  - 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
- C. Touchup Painting: Cleaning and touchup painting are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
- D. Touchup Priming: Cleaning and touchup priming are specified in Section 099600 "High-Performance Coatings."

END OF SECTION 051200

SECTION 052100  
STEEL JOIST FRAMING

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" for a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

A. Section Includes:

1. K-series steel joists.
2. KCS-type K-series steel joists.
3. K-series steel joist substitutes.
4. LH-series long-span steel joists.
5. DLH-series long-span steel joists.
6. Steel joist accessories.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for installing bearing plates in concrete.
2. Section 042000 "Unit Masonry" for installing bearing plates in unit masonry.
3. Section 051200 "Structural Steel Framing" for field-welded shear connectors.

1.3 DEFINITIONS

- A. SJI's "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."
- B. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support nonuniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of joist, accessory, and product.

B. Shop Drawings:

1. Include layout, designation, number, type, location, and spacing of joists.
2. Include joining and anchorage details; bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Welding certificates.
- C. Manufacturer certificates.
- D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- E. Mill Certificates: For each type of bolt.
- F. Comprehensive engineering analysis of special joists signed and sealed by the qualified professional engineer responsible for its preparation.
- G. Field quality-control reports.

## 1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications."
  - 1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.
- B. Welding Qualifications: Qualify field-welding procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle joists as recommended in SJI's "Specifications."
- B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

## 1.8 SEQUENCING

- A. Deliver steel bearing plates to be built into cast-in-place concrete and masonry construction.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated on Drawings.
  - 1. Use ASD; data are given at service-load level.
  - 2. Design special joists to withstand design loads with live-load deflections no greater than the following:



- a. Roof Joists: Vertical deflection of 1/360 of the span.

## 2.2 STEEL JOISTS

- A. K-Series Steel Joist: Manufactured steel joists of type indicated according to "Standard Specification for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.
  - 1. Joist Type: K-series steel joists and KCS-type K-series steel joists.
  - 2. K-Series Steel Joist Substitutes: Manufacture according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.
  - 3. Top-Chord Extensions: Extend top chords of joists with SJI's Type S top-chord extensions where indicated on Drawings, complying with SJI's "Specifications."
  - 4. Camber joists according to SJI's "Specifications."
  - 5. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).
- B. Long-Span Steel Joist: Manufactured steel joists according to "Standard Specification for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members; of joist type and end and top-chord arrangements as indicated on Drawings.
  - 1. Joist Type: LH-series long-span steel joists and DLH-series long-span steel joists.
  - 2. End Arrangement: Underslung.
  - 3. Top-Chord Arrangement: Pitched 1/8 inch per 12 inches (1:96), one way.
  - 4. Camber long-span steel joists according to SJI's "Specifications."
  - 5. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

## 2.3 PRIMERS

- A. Primer:
  - 1. SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.

## 2.4 STEEL JOIST ACCESSORIES

- A. Bridging:
  - 1. Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.
- B. Fabricate steel bearing plates from ASTM A36/A36M steel with integral anchorages of sizes and thicknesses indicated on Drawings. Shop prime paint.
- C. Furnish ceiling extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction.

1. Extend ends to within 1/2 inch (13 mm) of finished wall surface unless otherwise indicated on Drawings.
2. Finish: Plain, uncoated.

D. Welding Electrodes: Comply with AWS standards.

E. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

## 2.5 CLEANING AND SHOP PAINTING

A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by power-tool cleaning, SSPC-SP 3.

B. Do not prime paint joists and accessories to receive sprayed fire-resistive materials.

C. Apply one coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil thick.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

A. Do not install joists until supporting construction is in place and secured.

B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written instructions, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.
2. Space, adjust, and align joists accurately in location before permanently fastening.
3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
4. Delay rigidly connecting bottom-chord extensions to columns or supports until dead loads are applied.

C. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

D. Bolt joists to supporting steel framework using carbon-steel bolts.

- E. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

### 3.3 REPAIRS

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.
- B. Touchup Painting:
  - 1. Immediately after installation, clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists, bearing plates, abutting structural steel, and accessories.
    - a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
    - b. Apply a compatible primer of same type as primer used on adjacent surfaces.

### 3.4 FIELD QUALITY ASSURANCE

- A. Testing Agency: Department through the Professional to engage an independent qualified testing and inspecting agency to perform tests and inspections, including Special Inspections, and to submit reports.
- B. Visually inspect field welds according to AWS D1.1/D1.1M.
- C. Visually inspect bolted connections.
- D. Visually inspect installation of bridging.
- E. Prepare test and inspection reports.

END OF SECTION 052100

SECTION 053100

STEEL DECKING

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" for a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

A. Section Includes:

- 1. Roof deck.
- 2. Composite floor deck.
- 3. Noncomposite form deck.

B. Related Requirements:

- 1. Section 033000 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
- 2. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.
- 3. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.
- 4. Section 099113 "Exterior Painting" for repair painting of primed deck and finish painting of deck.
- 5. Section 099123 "Interior Painting" for repair painting of primed deck and finish painting of deck.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of deck, accessory, and product indicated.

B. Shop Drawings:

- 1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Product Certificates: For each type of steel deck.

- C. Product Test Reports: For tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
  - 1. Power-actuated mechanical fasteners.
- D. Evaluation Reports: For steel deck, from ICC-ES.
- E. Field quality-control reports.

## 1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
- C. FM Global Listing: Provide steel roof deck evaluated by FM Global and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."
- B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
- C. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- D. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.2 ROOF DECK

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ASC Profiles, Inc.; a Blue Scope Steel company.
  2. Canam United States; Canam Group Inc.
  3. CMC Joist & Deck.
  4. Consolidated Systems, Inc.; Metal Dek Group.
  5. Cordeck.
  6. DACS, Inc.
  7. Epic Metals Corporation.
  8. Marlyn Steel Decks, Inc.
  9. New Millennium Building Systems, LLC.
  10. Nucor Corp.; Vulcraft Group.
  11. Roof Deck, Inc.
  12. Valley Joist; Subsidiary of EBSCO Industries, Inc.
  13. Verco Manufacturing Co.
  14. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.
- B. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
1. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230), G90 (Z180) zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
    - a. Color: Manufacturer's standard.
  2. Deck Profile: As indicated.
  3. Profile Depth: As indicated.
  4. Design Uncoated-Steel Thickness: As indicated.
  5. Span Condition: Triple span or more.
  6. Side Laps: Overlapped.

## 2.3 COMPOSITE FLOOR DECK

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ASC Profiles, Inc.; a Blue Scope Steel company.
  2. Canam United States; Canam Group Inc.
  3. CMC Joist & Deck.
  4. Consolidated Systems, Inc.; Metal Dek Group.
  5. Cordeck.
  6. DACS, Inc.
  7. Epic Metals Corporation.
  8. Marlyn Steel Decks, Inc.
  9. New Millennium Building Systems, LLC.
  10. Nucor Corp.; Vulcraft Group.
  11. Roof Deck, Inc.
  12. Verco Manufacturing Co.
  13. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

- B. Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:
1. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230), G60 (Z180) zinc coating; with unpainted top surface and cleaned and pretreated bottom surface primed with manufacturer's standard gray or white baked-on, rust-inhibitive primer.
  2. Profile Depth: As indicated.
  3. Design Uncoated-Steel Thickness: As indicated.
  4. Span Condition: Triple span or more.

#### 2.4 NONCOMPOSITE FORM DECK

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ASC Profiles, Inc.; a Blue Scope Steel company.
  2. Canam United States; Canam Group Inc.
  3. CMC Joist & Deck.
  4. Consolidated Systems, Inc.; Metal Dek Group.
  5. Cordeck.
  6. DACS, Inc.
  7. Marlyn Steel Decks, Inc.
  8. New Millennium Building Systems, LLC.
  9. Nucor Corp.; Vulcraft Group.
  10. Roof Deck, Inc.
  11. Valley Joist; Subsidiary of EBSCO Industries, Inc.
  12. Verco Manufacturing Co.
  13. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.
- B. Noncomposite Form Deck: Fabricate ribbed-steel sheet noncomposite form-deck panels to comply with "SDI Specifications and Commentary for Noncomposite Steel Form Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:
1. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade 33 (230) minimum, with top and underside surface shop primed with manufacturer's standard baked-on, rust-inhibitive primer.
    - a. Color: Manufacturer's standard.
  2. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230), G60 (Z180) zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
    - a. Color: Manufacturer's standard.
  3. Profile Depth: as indicated.
  4. Design Uncoated-Steel Thickness: as indicated.
  5. Span Condition: As indicated.
  6. Side Laps: Overlapped.

## 2.5 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 (4.8-mm) minimum diameter.
- D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), not less than 0.0359-inch (0.91-mm) design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 31 for overhang and slab depth.
- G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.
- H. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.
- I. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch (1.52 mm) thick, with factory-punched hole of 3/8-inch (9.5-mm) minimum diameter.
- J. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck. For drains, cut holes in the field.
- K. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck, with 3-inch- (76-mm-) wide flanges and level recessed pans of 1-1/2-inch (38-mm) minimum depth. For drains, cut holes in the field.
- L. Galvanizing Repair Paint: ASTM A 780/A 780M.
- M. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.



### 3.2 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.
- B. Install temporary shoring before placing deck panels if required to meet deflection limitations.
- C. Locate deck bundles to prevent overloading of supporting members.
- D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
- E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

### 3.3 ROOF-DECK INSTALLATION

- A. Deck attachment shall be sufficient to develop diaphragm shear strength capacity indicated on the drawings, and shall be in accordance with the manufacturer's recommendations. Attachment guidelines indicated in sections 3.3B through 3.3D are minimum requirements only.
- B. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches (38 mm) long, and as follows:
  - 1. Weld Diameter: 5/8 inch (16 mm), nominal.
  - 2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds 12 inches (305 mm) apart in the field of roof and 6 inches (150 mm) apart in roof corners and perimeter, based on roof-area definitions in FMG Loss Prevention Data Sheet 1-28.
  - 3. Weld Washers: Install weld washers at each weld location where metal thickness is less than 0.028 inches. Weld washers shall have a minimum thickness of 0.0598 inches and have a nominal 3/8 inch diameter whole.
- C. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or 36 inches, and a minimum of 4 fasteners between supports, whichever results in more fasteners. Use one of the two attachment methods
  - 1. Mechanically fasten with self-drilling, No. 10 (4.8-mm-) diameter or larger, carbon-steel screws.

2. Mechanically clinch or button punch.
  3. Fasten with a minimum of 1-1/2-inch- (38-mm-) long welds.
- D. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm), with end joints as follows:
1. End Joints: Lapped 2 inches (51 mm) minimum.
- E. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and mechanically fasten flanges to top of deck. Space mechanical fasteners not more than 12 inches (305 mm) apart with at least one fastener at each corner.
1. Install reinforcing channels or zees in ribs to span between supports and mechanically fasten.
- F. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Mechanically fasten to substrate to provide a complete deck installation.
1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.
- G. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

### 3.4 FLOOR-DECK INSTALLATION

- A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
1. Weld Diameter: 5/8 inch (16 mm), nominal.
  2. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an average of 12 inches (305 mm) apart, but not more than 18 inches (457 mm) apart.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or 36 inches (914 mm), and as follows:
1. Mechanically fasten with self-drilling, No. 10 (4.8-mm-) diameter or larger, carbon-steel screws.
  2. Mechanically clinch or button punch.
  3. Fasten with a minimum of 1-1/2-inch- (38-mm-) long welds.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
1. End Joints: Butted.
- D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.

- E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

### 3.5 FIELD QUALITY ASSURANCE

- A. Testing Agency: Department through the Professional to engage an independent qualified testing and inspecting agency to perform tests and inspections, including Special Inspections, and to submit reports.
- B. Prepare test and inspection reports.
- C. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.
- D. Verify compliance of materials including profiles, material properties, type/grade, and base metal thickness.
- E. Verify size and location of welds, including support, sidelap, and perimeter welds.
- F. Check welds meet visual acceptance criteria.
- G. Verify manufacturer installation instructions for mechanical fasteners.
- H. Verify mechanical fasteners spacing and type.
- I. Check type and installation of support fasteners, type and installation of sidelap fasteners, and type and installation of perimeter fasteners.

### 3.6 PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780/A 780M and manufacturer's written instructions.
- B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.
  - 1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
  - 2. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

END OF SECTION 053100

## SECTION 05 50 00

### METAL FABRICATIONS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

A. Section Includes:

1. Steel framing and supports for overhead doors.
2. Steel framing and supports for countertops.
3. Steel tube reinforcement for low partitions.
4. Steel framing and supports for mechanical and electrical equipment.
5. Steel framing and supports for applications where framing and supports are not specified in other Sections.
6. Elevator machine beams, divider beams, and hoist beams.
7. Steel shapes for supporting elevator door sills.
8. Shelf angles.
9. Metal ladders.
10. Ladder safety cages.
11. Elevator pit sump covers.
12. Miscellaneous steel trim including steel angle corner guards, steel edgings, and loading-dock edge angles.
13. Metal bollards.
14. Metal downspout boots.
15. Loose bearing and leveling plates for applications where they are not specified in other Sections.

B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

C. Related Requirements:

1. Section 03 30 00 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
2. Section 04 20 00 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
3. Section 05 12 00 "Structural Steel Framing."
4. Section 12 93 00 "Site Furnishings" for bicycle racks.
5. Section 32 93 00 "Plants" for tree grates.

### 1.3 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

### 1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Metal nosings.
  - 2. Grout.
- B. Shop Drawings: Show fabrication and installation details. Include details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:
  - 1. Steel framing and supports for operable partitions.
  - 2. Steel framing and supports for overhead doors.
  - 3. Steel framing and supports for countertops.
  - 4. Steel tube reinforcement for low partitions.
  - 5. Steel framing and supports for mechanical and electrical equipment.
  - 6. Steel framing and supports for applications where framing and supports are not specified in other Sections.
  - 7. Elevator machine beams, divider beams, and hoist beams.
  - 8. Steel shapes for supporting elevator door sills.
  - 9. Steel pipe columns for supporting wood frame construction.
  - 10. Shelf angles.
  - 11. Metal ladders.
  - 12. Ladder safety cages.
  - 13. Alternating tread devices.
  - 14. Metal ships' ladders.
  - 15. Elevator pit sump covers.
  - 16. Miscellaneous steel trim including steel angle corner guards, steel edgings, and loading-dock edge angles.
  - 17. Metal bollards.
  - 18. Pipe guards.
  - 19. Metal downspout boots.
  - 20. Loose steel lintels.
- C. Samples for Verification: For each type and finish of extruded nosing.
- D. Delegated-Design Submittal: For ladders, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer.

- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- D. Research/Evaluation Reports: For post-installed anchors, from ICC-ES.

#### 1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

#### 1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

### **PART 2 - PRODUCTS**

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, licensed in the Commonwealth of Pennsylvania, to design ladders.
- B. Structural Performance of Alternating Tread Devices: Alternating tread devices shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
  - 1. Uniform Load: 100 lbf/sq. ft.
  - 2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.
  - 3. Uniform and concentrated loads need not be assumed to act concurrently.
  - 4. Alternating Tread Device Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

#### 2.2 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- C. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

- D. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.
- E. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.
- F. Zinc-Coated Steel Wire Rope: ASTM A 741.
  - 1. Wire-Rope Fittings: Hot-dip galvanized-steel connectors with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.
- G. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.
- H. Aluminum Plate and Sheet: ASTM B 209, Alloy 6061-T6.
- I. Aluminum Extrusions: ASTM B 221, Alloy 6063-T6.
- J. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.
- K. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.

### 2.3 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
  - 1. Provide stainless-steel fasteners for fastening aluminum.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.
- C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers; Alloy Group 1.
- D. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
  - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- E. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.
- F. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.
- G. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

## 2.4 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
- B. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- E. Concrete: Comply with requirements in Section 03 30 00 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi.

## 2.5 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
  1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  2. Obtain fusion without undercut or overlap.
  3. Remove welding flux immediately.
  4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.



- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

## 2.6 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
  - 1. Fabricate units from slotted channel framing where indicated.
  - 2. Furnish inserts for units installed after concrete is placed.
- C. Galvanize miscellaneous framing and supports located in exterior construction and where indicated.
- D. Prime interior miscellaneous framing and supports where to remain exposed.

## 2.7 SHELF ANGLES

- A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.
  - 1. Provide mitered and welded units at corners.
  - 2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.
- B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.
- C. Galvanize shelf angles located in exterior walls.

## 2.8 METAL LADDERS

- A. General:
  - 1. Comply with ANSI A14.3, except for elevator pit ladders.
  - 2. For elevator pit ladders, comply with ASME A17.1/CSA B44.

B. Steel Ladders:

1. Space siderails 16 inches apart unless otherwise indicated.
2. Siderails: Continuous, 3/8-by-2-1/2-inch steel flat bars, with eased edges.
3. Rungs: 3/4-inch- diameter steel bars.
4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
5. Provide nonslip surfaces on top of each rung.
6. Galvanize exterior ladders, including brackets.
7. Prime interior ladders, including brackets and fasteners.

2.9 ELEVATOR PIT SUMP COVERS

- A. Fabricate from 1/8-inch rolled-steel floor plate with four 1-inch- diameter holes for water drainage and for lifting.
- B. Fabricate from welded or pressure-locked steel bar grating. Limit openings in gratings to no more than 1/2 inch in least dimension.
- C. Provide steel angle supports as indicated.

2.10 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
  1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
- C. Galvanize and prime exterior miscellaneous steel trim.
- D. Prime miscellaneous interior steel trim.

2.11 METAL BOLLARDS

- A. Fabricate metal bollards from Schedule 40 steel pipe.
- B. Fabricate sleeves for bollard anchorage from steel pipe or tubing with 1/4-inch- thick steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches deep and 3/4 inch larger than OD of bollard.
- C. Prime bollards with primer specified in Section 09 91 13 "Exterior Painting."

2.12 ABRASIVE METAL NOSINGS

- A. Extruded Units: Aluminum, with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Interior: Balco, Inc.; Illumitread Model 4199 and Exterior: Balco, Inc.; Illumitread Model P-3310-PL-100 or comparable product by one of the following, or equal approved by the Professional:
    - a. Amstep Products.
    - b. Balco, Inc.
    - c. Wooster Products Inc.
  2. Provide ribbed units, with abrasive filler strips projecting 1/16 inch above aluminum extrusion.
- B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.
- C. Drill for mechanical anchors and countersink. Locate holes not more than 4 inches from ends and not more than 12 inches o.c., evenly spaced between ends, unless otherwise indicated. Provide closer spacing if recommended by manufacturer.
1. Provide two rows of holes for units more than 5 inches wide, with two holes aligned at ends and intermediate holes staggered.
- D. Apply clear lacquer to concealed surfaces of extruded units.

#### 2.13 METAL DOWNSPOUT BOOTS

- A. Provide downspout boots made from cast iron in heights indicated with inlets of size and shape to suit downspouts. Provide units with flanges and holes for countersunk anchor bolts.
- B. Prime cast-iron downspout boots with primer specified in Section 09 91 13 "Exterior Painting."

#### 2.14 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
- B. Galvanize plates located in exterior construction and where indicated.
- C. Prime interior loose bearing and leveling plates where to remain exposed.

#### 2.15 LOOSE STEEL LINTELS

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.
- B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span, but not less than 8 inches unless otherwise indicated.
- C. Galvanize loose steel lintels located in exterior wall construction.

- D. Prime interior loose steel lintels where to remain exposed.

## 2.16 STEEL WELD PLATES AND ANGLES

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

## 2.17 FINISHES, GENERAL

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

## 2.18 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
  - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
  - 2. Galvanize miscellaneous metal fabrications specified in this Section where exposed to exterior or embedded in exterior roof or wall construction unless otherwise indicated.
- B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
- C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
  - 1. Shop prime with universal shop primer.
- D. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:
  - 1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - 2. Items Indicated to Receive Primers Specified in Section 09 96 00 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - 3. Other Items: SSPC-SP 3, "Power Tool Cleaning."
- E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
  - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

## 2.19 ALUMINUM FINISHES

- A. As-Fabricated Finish: AA-M12.
- B. Clear Anodic Finish: AAMA 611, Class I, AA-M12C22A41.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION, GENERAL**

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
  - 1. Extruded Aluminum: Two coats of clear lacquer.

### **3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS**

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports for overhead doors securely to, and rigidly brace from, building structure.
- C. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.
  - 1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

### 3.3 INSTALLING METAL BOLLARDS

- A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.
- B. Anchor bollards in concrete with pipe sleeves preset and anchored into concrete. Fill annular space around bollard solidly with nonshrink grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward bollard.
- C. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.
- D. Fill bollards solidly with concrete, mounding top surface to shed water.

### 3.4 INSTALLING NOSINGS

- A. Center nosings on tread widths unless otherwise indicated.
- B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.

### 3.5 INSTALLING BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with nonshrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

### 3.6 ADJUSTING AND CLEANING

- A. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

**END OF SECTION 05 50 00**

**SECTION 05 51 13**  
**METAL PAN STAIRS**

**PART 1 - GENERAL**

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

A. Section Includes:

- 1. Preassembled steel stairs with concrete-filled treads.
- 2. Steel tube railings attached to metal stairs.
- 3. Steel tube handrails attached to walls adjacent to metal stairs.
- 4. Railing gates at the level of exit discharge.

B. Related Requirements:

- 1. Section 03 30 00 "Cast-in-Place Concrete" for concrete fill for stair treads and platforms.
- 2. Section 05 52 13 "Pipe and Tube Railings" for pipe and tube railings.

1.3 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- C. Coordinate locations of hanger rods and struts with other work so that they do not encroach on required stair width and are within the fire-resistance-rated stair enclosure.

1.4 ACTION SUBMITTALS

A. Product Data: For metal pan stairs and the following:

- 1. Abrasive nosings.

2. Paint products.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each type and finish of nosing.

D. Delegated-Design Submittal: For stairs and railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

#### 1.6 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

### **PART 2 - PRODUCTS**

#### 2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, licensed in the Commonwealth of Pennsylvania, to design stairs and railings.

B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: 100 lbf/sq. ft.

2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.

3. Uniform and concentrated loads need not be assumed to act concurrently.

4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.

5. Limit deflection of treads, platforms, and framing members to  $L/360$  or  $1/4$  inch, whichever is less.

C. Structural Performance of Railings: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:



1. Handrails and Top Rails of Guards:
  - a. Uniform load of 50 lbf/ft. applied in any direction.
  - b. Concentrated load of 200 lbf applied in any direction.
  - c. Uniform and concentrated loads need not be assumed to act concurrently.
2. Infill of Guards:
  - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
  - b. Infill load and other loads need not be assumed to act concurrently.

D. Seismic Performance of Stairs: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor: 1.5.

## 2.2 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- C. Steel Tubing: ASTM A 500 (cold formed) or ASTM A 513.
- D. Uncoated, Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, either commercial steel, Type B, or structural steel, Grade 25, unless another grade is required by design loads; exposed.
- E. Uncoated, Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, either commercial steel, Type B, or structural steel, Grade 30, unless another grade is required by design loads.
- F. Aluminum Extrusions: ASTM B 221, Alloy 6063-T6.

## 2.3 ABRASIVE NOSINGS

- A. Extruded Units: Aluminum units with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions.
  1. Basis-of-Design Product: Subject to compliance with requirements, provide Interior: Balco, Inc.; and Exterior: Illumitread Model 4199 and Balco, Inc.; Illumitread Model P-3310-PL-100 or comparable product by one of the following, or equal approved by the Professional:
    - a. Amstep Products.
    - b. Balco, Inc.
    - c. Wooster Products Inc.
  2. Provide ribbed units, with abrasive filler strips projecting 1/16 inch above aluminum extrusion.

- B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.
- C. Apply clear lacquer to concealed surfaces of extruded units set into concrete.

## 2.4 FASTENERS

- A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.
- B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.
- C. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
  - 1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for exterior stairs and stairs indicated to be galvanized.
- D. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.
  - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
  - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

## 2.5 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
- B. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Concrete Materials and Properties: Comply with requirements in Section 03 30 00 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
- E. Welded Wire Reinforcement: ASTM A 185/A 185M, 6 by 6 inches, W1.4 by W1.4, unless otherwise indicated.

## 2.6 FABRICATION, GENERAL

- A. Provide complete stair assemblies, including metal framing, hangers, struts, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
  - 1. Join components by welding unless otherwise indicated.
  - 2. Use connections that maintain structural value of joined pieces.
- B. Preassembled Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Form exposed work with accurate angles and surfaces and straight edges.
- F. Weld connections to comply with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Weld exposed corners and seams continuously unless otherwise indicated.
  - 5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 4 welds: good quality, uniform undressed weld with minimal splatter.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.

## 2.7 STEEL-FRAMED STAIRS

- A. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," Commercial Class, unless more stringent requirements are indicated.
- B. Stair Framing:
  - 1. Fabricate stringers of channels.
    - a. Provide closures for exposed ends of channel stringers.

2. Construct platforms of channel headers and miscellaneous framing members as needed to comply with performance requirements.
  3. Weld stringers to headers; weld framing members to stringers and headers.
  4. Where stairs are enclosed by gypsum board assemblies, provide hanger rods or struts to support landings from floor construction above or below. Locate hanger rods and struts where they do not encroach on required stair width and are within the fire-resistance-rated stair enclosure.
  5. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.
- C. Metal Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements, but not less than 0.067 inch, 14-gage.
1. Steel Sheet: Uncoated cold-rolled steel sheet.
  2. Directly weld metal pans to stringers; locate welds on top of subtreads where they are concealed by concrete fill. Do not weld risers to stringers.
  3. Shape metal pans to include nosing integral with riser.
  4. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads. Weld subplatforms to platform framing.
    - a. Smooth Soffit Construction: Construct subplatforms with flat metal under surfaces to produce smooth soffits.

## 2.8 STAIR RAILINGS

- A. Comply with applicable requirements in Section 05 52 13 "Pipe and Tube Railings."
1. Fabricate newels of square steel tubing and provide newel caps of pressed steel, as shown.
  2. Rails may be bent at corners, rail returns, and wall returns, instead of using prefabricated fittings.
- B. Steel Tube Railings: Fabricate railings to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of tube, post spacings, and anchorage, but not less than that needed to withstand indicated loads.
1. Rails and Posts: 1-5/8-inch- diameter top and bottom rails and posts.
  2. Picket Infill: 1/2-inch- round pickets spaced less than 4 inches clear.
  3. Gates: Form gates from steel tube of same size and shape as top rails, with infill to match guards. Provide with cam-type, self-closing hinges for fastening to wall and overlapping stop with rubber bumper to prevent gate from opening in direction opposite egress.

- C. Welded Connections: Fabricate railings with welded connections. Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
  - 1. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for [Type 1 welds: no evidence of a welded joint] [Type 2 welds: completely sanded joint, some undercutting and pinholes are okay] [Type 3 welds: partially dressed weld with spatter removed] [Type 4 welds: good quality, uniform undressed weld with minimal splatter] as shown in NAAMM AMP 521.
- D. Form changes in direction of railings by bending.
- E. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- F. Close exposed ends of railing members with prefabricated end fittings.
- G. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.
- H. Connect posts to stair framing by direct welding unless otherwise indicated.
- I. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.
  - 1. For nongalvanized railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.
  - 2. Metal Fittings for Steel Pipe Railings:
    - a. Basis-of-Design Products: Subject to compliance with requirements, provide the following products or comparable product, or equal approved by the Professional:
      - 1) Wall Brackets: Blum, Julius & Co., Inc.; Model #386, malleable iron.
      - 2) End Flanges: Blum, Julius & Co., Inc.; Model #911, pressed steel.
      - 3) End Caps: Blum, Julius & Co., Inc.; Model #938, steel, flush with hemispherical end and integral alignment sleeves.
      - 4) Expansion Bolts: Metal shield type including washers.
- J. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

## 2.9 FINISHES

- A. Finish metal stairs after assembly.
- B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
  2. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- C. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 3, "Power Tool Cleaning."
- D. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLING METAL PAN STAIRS**

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.
- C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.
- D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- E. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- F. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.
- G. Place and finish concrete fill for treads and platforms to comply with Section 03 30 00 "Cast-in-Place Concrete."
1. Install abrasive nosings with anchors fully embedded in concrete. Center nosings on tread width.

#### **3.2 INSTALLING RAILINGS**

- A. Adjust railing systems before anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated or, if not indicated, as required by design loads. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:
1. Anchor posts to steel by welding to steel supporting members.

2. Anchor handrail ends to concrete and masonry with steel round flanges welded to rail ends and anchored with postinstalled anchors and bolts.
- B. Attach handrails to wall with wall brackets. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads. Secure wall brackets to building construction as required to comply with performance requirements and as follows:
1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
  2. For hollow masonry anchorage, use toggle bolts.
  3. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
  4. For steel-framed partitions, use one of the following methods of attachment:
    - a. Use hanger or lag bolts set into fire-retardant-treated wood backing between studs. Coordinate with stud installation to locate backing members.
    - b. Use self-tapping screws fastened to steel framing or to concealed steel reinforcements.
    - c. Use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

### 3.3 ADJUSTING AND CLEANING

- A. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

**END OF SECTION 05 51 13**

## SECTION 05 52 13

### PIPE AND TUBE RAILINGS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section includes steel pipe and tube railings.
- B. Related Requirements:
  - 1. Section 05 51 12 "Metal Pan Stairs" for steel tube railings associated with metal pan stairs.

##### 1.3 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Manufacturer's product lines of mechanically connected railings.
  - 2. Railing brackets.
  - 3. Grout, anchoring cement, and paint products.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- C. Samples: For each type of exposed finish required and for fittings and brackets.
- D. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.



## 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified professional engineer.
- B. Welding certificates.
- C. Evaluation Reports: For post-installed anchors, from ICC-ES.

## 1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

## 1.8 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

## **PART 2 - PRODUCTS**

### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, licensed in the Commonwealth of Pennsylvania, to design railings, including attachment to building construction.
- B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
  - 1. Handrails and Top Rails of Guards:
    - a. Uniform load of 50 lbf/ ft. applied in any direction.
    - b. Concentrated load of 200 lbf applied in any direction.
    - c. Uniform and concentrated loads need not be assumed to act concurrently.
  - 2. Infill of Guards:
    - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
    - b. Infill load and other loads need not be assumed to act concurrently.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F.

## 2.2 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.
  - 1. Provide type of bracket with flange tapped for concealed anchorage to threaded hanger bolt and that provides 2-1/4-inch clearance from inside face of handrail to finished wall surface.

## 2.3 STEEL

- A. Tubing: ASTM A 500 (cold formed) or ASTM A 513.
- B. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
  - 1. Provide 1-1/4 inch (1.6 inch OD) steel pipe railings unless otherwise indicated.
  - 2. Provide galvanized finish for exterior installations and where indicated.
- C. Plates, Shapes, and Bars: ASTM A 36/A 36M.
- D. Perforated Metal: Cold-rolled steel sheet, ASTM A 1008/A 1008M, or hot-rolled steel sheet, ASTM A 1011/A 1011M, commercial steel Type B, 0.060 inch, 16-gage thick, with 1/4-inch holes 3/8 inch o.c. in staggered rows.

## 2.4 FASTENERS

- A. General: Provide the following:
  - 1. Ungalvanized-Steel Railings: Plated steel fasteners complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5 for zinc coating.
  - 2. Hot-Dip Galvanized Railings: Type 304 stainless-steel or hot-dip zinc-coated steel fasteners complying with ASTM A 153/A 153M or ASTM F 2329 for zinc coating.
- B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.
  - 1. Metal Fittings for Steel Pipe Railings:
    - a. Basis-of-Design Products: Subject to compliance with requirements, provide the following products or comparable product, or equal approved by Professional:
      - 1) Wall Brackets: Blum, Julius & Co., Inc.; Model #386, malleable iron.
      - 2) End Flanges: Blum, Julius & Co., Inc.; Model #911, pressed steel.
      - 3) End Caps: Blum, Julius & Co., Inc.; Model #938, steel, flush with hemispherical end and integral alignment sleeves.
      - 4) Expansion Bolts: Metal shield type including washers.
- C. Fasteners for Interconnecting Railing Components:

1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.
  2. Provide Phillips flat-head machine screws for exposed fasteners unless otherwise indicated.
- D. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry and 4 times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.
1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
  2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

## 2.5 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Etching Cleaner for Galvanized Metal: Complying with MPI #25.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Shop Primers: Provide primers that comply with Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
- E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- F. Epoxy Intermediate Coat: Complying with MPI #77 and compatible with primer and topcoat.
- G. Polyurethane Topcoat: Complying with MPI #72 and compatible with undercoat.
- H. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- I. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
  1. Water-Resistant Product: At exterior locations provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

## 2.6 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

- B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that are exposed to weather in a manner that excludes water. Provide weep holes where water may accumulate.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with welded connections unless otherwise indicated.
- H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove flux immediately.
  - 4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
- I. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
  - 1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
- J. Form changes in direction by bending.
- K. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- L. Close exposed ends of railing members with prefabricated end fittings.
- M. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.
- N. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
  - 1. At brackets and fittings fastened to gypsum board partitions, provide crush-resistant fillers or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.
- O. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

- P. For railing posts set in concrete, provide steel sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with metal plate forming bottom closure.
- Q. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

## 2.7 STEEL FINISHES

- A. Galvanized Railings:
  - 1. Hot-dip galvanize exterior steel railings, including hardware, after fabrication.
  - 2. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.
  - 3. Comply with ASTM A 153/A 153M for hot-dip galvanized hardware.
  - 4. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
  - 5. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
- C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.
- D. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves; however, galvanize anchors to be embedded in exterior concrete or masonry.
- E. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with requirements indicated below:
  - 1. Exterior Railings: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - 2. Other Railings: SSPC-SP 3, "Power Tool Cleaning."
- F. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
  - 1. Shop prime uncoated railings with primers specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
  - 2. Do not apply primer to galvanized surfaces.
- G. Shop-Painted Finish: Comply with Section 09 91 13 "Exterior Painting."
  - 1. Color: As selected by Architect from manufacturer's full range.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements are clearly marked for Installer. Locate reinforcements and mark locations if not already done.

### **3.2 INSTALLATION, GENERAL**

- A. Fit exposed connections together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
  - 1. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
  - 2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
  - 3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
- C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
- D. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

### **3.3 RAILING CONNECTIONS**

- A. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

### **3.4 ANCHORING POSTS**

- A. Use metal sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Cover anchorage joint with flange of same metal as post, welded to post after placing anchoring material.
- C. Leave anchorage joint exposed with 1/8-inch buildup, sloped away from post.

### 3.5 ATTACHING RAILINGS

- A. Anchor railing ends at walls with round flanges anchored to wall construction and welded to railing ends.
- B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends.
- C. Attach railings to wall with wall brackets, except where end flanges are used. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
- D. Secure wall brackets and railing end flanges to building construction as follows:
  - 1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
  - 2. For hollow masonry anchorage, use toggle bolts.
  - 3. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
  - 4. For steel-framed partitions, use one of the following methods of attachment:
    - a. Use hanger or lag bolts set into fire-retardant-treated wood backing between studs. Coordinate with stud installation to locate backing members.
    - b. Use self-tapping screws fastened to steel framing or to concealed steel reinforcements.
    - c. Use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

### 3.6 ADJUSTING AND CLEANING

- A. Clean by washing thoroughly with clean water and soap and rinsing with clean water.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A 780/A 780M.

### 3.7 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period so that no evidence remains of correction work. Return items that cannot be refinished in the field to the shop, make required alterations, and refinish entire unit, or provide new units.

**END OF SECTION 05 52 13**

**SECTION 05 70 00**  
**DECORATIVE METAL PANELS**

**PART 1 - GENERAL**

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

- A. Section Includes: Decorative metal panels used for:
  - 1. Metal Screen Wall.
- B. Related Sections:
  - 1. Section 05 50 00 "Metal Fabrications" for steel frame for television mounting.

1.3 REFERENCES

- A. AA – Aluminum Association, *Aluminum Standards and Data*.
- B. AAMA 2604 – *High Performance Organic Coatings on Aluminum Extrusions and Panels*.

1.4 SUBMITTALS

- A. Product Data: Submit for:
  - 1. Coatings.
  - 2. Fasteners.
- B. Manufacturer Instructions: Submit for:
  - 1. Delivery, storage, and handling.
  - 2. Installation.
  - 3. Cleaning and repair.
- C. Samples: Submit two pieces not less than 8 x 8 inches in size and showing portion of pattern to be provided and appearance of specified finish.
- D. Shop Drawings: For each type of panel, post and fabricated accessory, show material, thickness, dimensions, cutouts and penetrations, finish, fasteners, and other information necessary to describe work to be provided. Show dimensioned plan view of entire screen wall. Show required anchoring into site wall.
- E. Certification: Submit letter from manufacturer stating that products comply with specifications.

1.5 QUALITY ASSURANCE

- A. Installer: Firm with five years of experience installing decorative metalwork.
- B. Pre-fabrication: Confirm on-site dimensions and radius of site wall to receive posts and screen panel.
- C. Pre-Installation Meeting:



1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's instructions. Protect against damage.

## 1.7 WARRANTY

- A. Submit panel manufacturer's limited warranty against defects in material and workmanship:
  1. Panels: Twenty years.
  2. Factory-Applied Coatings: Ten years.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURER

- A. Basis-of-design: Subject to compliance with the requirements, provide Parasoleil metal panels, Lemon Drop pattern, or a comparable product by one of the following, or equal as approved by the Professional:
  1. ReVamp Panels, Foliage Frenzy pattern
  2. Artisan Panels, Inc., Stars pattern 97

### 2.2 PERFORMANCE CRITERIA AND SYSTEM

- A. Comply with:
  1. Building codes required by Authorities Having Jurisdiction over building.
  2. International Building Code 2015 edition.
- B. Structural Requirements:
  1. Loads:
    - a. Wind Load 100 mph.
  2. Thermal Movement: Allow for 180 degrees F thermal variation.
- C. Dissimilar Metals: Design installation to protect against corrosion due to contact between dissimilar metals.
- D. Panel Sizes and Configuration:
  1. Provide as shown on Drawings. Where not shown on Drawings, panels shall be in accordance with overall design intent and as determined by handling and installation conditions.
  2. Do not allow unsupported edges.

### 2.3 MATERIALS:

- A. Aluminum:
  1. Material: AA 5000 series, H32 temper, aluminum with recycled content of 60 percent.
  2. Thickness: 3/16" or as shown on shop drawings.
  3. Finish: Factory-Applied Powder Coated:
    - a. Performance: AAMA 2604.
    - b. Color: To be selected from manufacturer's full range
    - c. Color, gloss, and finish pattern variation from panel-to-panel is not acceptable.

### 2.4 FABRICATION

- A. Cutting and Cutouts: Cut metal with laser cutter capable of 1/16-inch tolerance. Remove burrs in accordance with WBTD recommended "Deburring & Edge Finishing Handbook" by LaRoux K. Gillespie, Level D, without magnification.
- B. Make holes for fasteners in factory to extent practical.
- C. Complete fabrication before applying finishes.

## 2.5 ACCESSORIES

- A. Clips: Provide clips or other attachment devices where it is not practical to attach panels directly to substrate. Design clips to minimize their visibility.
- B. Fasteners:
  - 1. Attachment to Steel: Bi-metal, self-drilling, self-tapping screws:
    - a. Fasteners shall be immune to hydrogen-assisted stress-corrosion cracking.
    - b. Head and Shank: Non-magnetic, 300 series stainless steel.
    - c. Drill Point: Carbon steel.
    - d. Galvanic Barrier Coating with zinc-rich baked-on polymer base coat and aluminum-rich baked-on polymer top coat.
  - 2. Color: Color of exposed-to-view fasteners in surfaces with factory-applied finishes shall be compatible with panel finish.
  - 3. Size and Spacing: As required to satisfy conditions of use; loads on fasteners shall not exceed 25 percent of average ultimate strength.
  - 4. Washers: Provide bonded neoprene washers where necessary to prevent water intrusion.
- C. Galvanic Barriers: Types recommended by manufacturer for conditions of use.
- D. Repair Compound: Automotive scratch-filling cream or wax.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verification of Conditions: Verify that conditions are ready for installation of panels. Correct defects before proceeding.

### 3.2 INSTALLATION

- A. Install plumb, level, square, and securely and in accordance with manufacturer's instructions.
- B. Factory-Painted Surfaces: Do not cut, drill, or weld unless required by approved shop drawings.
- C. Protect against contact between dissimilar metals.

### 3.3 PROTECTION AND REPAIRS

- A. Protect installed panels from damage.
- B. Repair minor scratches in powder coated surfaces with repair compound.
- C. Damaged panels that cannot be repaired to Architect's satisfaction shall be removed and replaced with new panels.

**END OF SECTION 05 70 00**

## SECTION 06 10 53

### MISCELLANEOUS ROUGH CARPENTRY

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Rooftop equipment bases and support curbs.
  - 2. Wood blocking, cants, and nailers.
  - 3. Plywood backing panels.
- B. Related Requirements:
  - 1. Section 06 16 00 "Sheathing" for sheathing.

##### 1.3 DEFINITIONS

- A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.
- B. Dimension Lumber: Lumber of 2 inches nominal or greater size but less than 5 inches nominal size in least dimension.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
  - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used, net amount of preservative retained, and chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated materials.
  - 2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
  - 3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
  - 4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

5. Include copies of warranties from chemical-treatment manufacturers for each type of treatment.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For the following, from ICC-ES:
  1. Preservative-treated wood.
  2. Fire-retardant-treated wood.
  3. Power-driven fasteners.
  4. Post-installed anchors.

## 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.
- B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

## **PART 2 - PRODUCTS**

### 2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
  1. Factory mark each piece of lumber with grade stamp of grading agency.
  2. Dress lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

### 2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWWA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.
  1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.

- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: Treat all miscellaneous carpentry unless otherwise indicated.

### 2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated or where required by codes adopted by authorities having jurisdiction, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
  - 1. Treatment shall not promote corrosion of metal fasteners.
  - 2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated on Drawings.
  - 3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
  - 4. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D 5664, and design value adjustment factors shall be calculated according to ASTM D 6841.
- C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.
- D. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.
- E. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
- F. Application: Treat all miscellaneous carpentry unless otherwise indicated.

### 2.4 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated on Drawings and lumber for support or attachment of other construction, including the following:
  - 1. Blocking.
  - 2. Nailers.
  - 3. Rooftop equipment bases and support curbs.
  - 4. Cants.
  - 5. Furring.

- B. Dimension Lumber Items: Standard, Stud, or No. 3 grade lumber of any species.
- C. Concealed Boards: 19 percent maximum moisture content of any of the following species and grades:
  - 1. Mixed southern pine or southern pine, No. 3 grade; SPIB.
  - 2. Hem-fir or hem-fir (north), Standard or No. 3 Common grade; NLGA, WCLIB, or WWPA.
  - 3. Spruce-pine-fir (south) or spruce-pine-fir, Standard or No. 3 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
- D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
- F. For furring strips for installing plywood paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

## 2.5 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: Plywood, DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2-inch nominal thickness.

## 2.6 FASTENERS

- A. General: Provide fasteners of size and type indicated on Drawings that comply with requirements specified in this article for material and manufacture.
  - 1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated with ACQ or another preservative treatment process other than inorganic boron (SBX), or in area of high relative humidity, provide fasteners of Type 304 stainless steel.
  - 2. Where carpentry is pressure-preservative treated with inorganic boron (SBX) and enclosed within the finished building, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Screws for Fastening to Metal Framing: Length as recommended by screw manufacturer for material being fastened and complying with the following:
  - 1. ASTM C 1002 for "drywall-type" non-load-bearing steel framing with a base-metal thickness of 0.0329 inch, 20-gage, or less.
  - 2. ASTM C 954 for cold-formed metal framing.
- D. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
  - 1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
  - 2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

## 2.7 MISCELLANEOUS MATERIALS

- A. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Carlisle Coatings & Waterproofing Inc.; CCW-705-TWF Thru-Wall Flashing.
    - b. Grace Construction Products; W.R. Grace & Co. – Conn.; Vycor Plus Self-Adhered Flashing.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.
- D. Do not splice structural members between supports unless otherwise indicated.
- E. Provide blocking and framing as indicated on Drawings and as required to support facing materials, fixtures, specialty items, and trim.
  - 1. Provide metal clips for fastening gypsum board at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.
- F. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated on Drawings and as follows:
  - 1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
  - 2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal thickness.
  - 3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. and to solidly fill space below partitions.
- G. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function

of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

- H. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
  - 1. Use inorganic boron for items that are continuously protected from liquid water.
  - 2. Use copper naphthenate for items not continuously protected from liquid water.
- I. Where wood-preservative-treated lumber is installed adjacent to steel, including galvanized steel, install continuous flexible flashing separator between wood and metal.
- J. Securely attach carpentry work to substrate by anchoring and fastening as indicated on Drawings, complying with the following:
  - 1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
  - 2. ICC-ES evaluation report for fastener.
- K. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

### 3.2 WOOD BLOCKING AND NAILER INSTALLATION

- A. Install where indicated on Drawings and where required for attaching other work. Form to shapes indicated on Drawings and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading with bolts at 24-inch centers unless otherwise indicated on Drawings. Recess bolts and nuts flush with surfaces unless otherwise indicated.

### 3.3 PROTECTION

- A. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

**END OF SECTION 06 10 53**



## SECTION 06 16 00

### SHEATHING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:

1. Wall sheathing.
2. Parapet sheathing.
3. Sheathing joint and penetration treatment.

- B. Related Requirements:

1. Section 06 10 53 "Miscellaneous Rough Carpentry" for plywood backing panels.
2. Section 07 25 00 "Weather Barriers" for water-resistive barrier applied over wall sheathing.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used, net amount of preservative retained, and chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated materials.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5516.
4. For products receiving waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
5. Include copies of warranties from chemical-treatment manufacturers for each type of treatment.
6. For composite wood products, indicate that product contains no added urea formaldehyde resins.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For the following, from ICC-ES:
  - 1. Wood-preservative-treated plywood.
  - 2. Fire-retardant-treated plywood.

#### 1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

### **PART 2 - PRODUCTS**

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: As tested according to ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

#### 2.2 WOOD PANEL PRODUCTS

- A. Thickness: As needed to comply with requirements specified, but not less than thickness indicated on Drawings.
- B. Factory mark panels to indicate compliance with applicable standard.

#### 2.3 PRESERVATIVE-TREATED PLYWOOD

- A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.
  - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
- C. Application: Treat all plywood unless otherwise indicated.

## 2.4 FIRE-RETARDANT-TREATED PLYWOOD

- A. General: Where fire-retardant-treated materials are indicated on Drawings or where required by codes adopted by authorities having jurisdiction, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
  - 1. Use treatment that does not promote corrosion of metal fasteners.
  - 2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
  - 3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201/D 3201M at 92 percent relative humidity. Use where exterior type is not indicated.
  - 4. Design Value Adjustment Factors: Treated lumber plywood shall be tested according to ASTM D 5516 and design value adjustment factors shall be calculated according to ASTM D 6305. Span ratings after treatment shall be not less than span ratings specified. Where high-temperature fire-retardant treatment is indicated, span ratings for temperatures up to 170 deg F shall be not less than span ratings specified.
- C. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.
- E. Application: Treat all plywood unless otherwise indicated.

## 2.5 WALL SHEATHING

- A. Glass-Mat Gypsum Sheathing: ASTM C 1177/1177M.
  - 1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by professional:
    - a. CertainTeed Corporation; GlasRoc.
    - b. Georgia-Pacific Building Products; Dens-Glass Gold.
    - c. National Gypsum Company; Gold Bond eXP Extended Exposure Sheathing.
    - d. United States Gypsum Company; Securock.
  - 2. Type and Thickness: Type X, 5/8 inch thick.

## 2.6 PARAPET SHEATHING

- A. Plywood Sheathing: DOC PS 1, Exterior, Structural I sheathing.
  - 1. Span Rating: Not less than 24/0.

2. Nominal Thickness: Not less than 1/2 inch.

## 2.7 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
  1. For wall and parapet sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- D. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
- E. Screws for Fastening Glass-Mat Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.
  1. For steel framing less than 0.0329 inch, 20-gage, thick, use screws that comply with ASTM C 1002.
  2. For steel framing from 0.033 inch, 20-gage, to 0.112 inch, 11-gage, thick, use screws that comply with ASTM C 954.

## 2.8 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

- A. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C 834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.
  1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2 inches wide, 10 by 10 or 10 by 20 threads/inch, of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
- C. Securely attach to substrate by fastening as indicated, complying with the following:

1. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
  2. ICC-ES evaluation report for fastener.
- D. Coordinate wall and parapet sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
- F. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

### 3.2 WOOD STRUCTURAL PANEL INSTALLATION

- A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.
- B. Fastening Methods: Fasten panels as indicated below:
1. Parapet Sheathing: Screw to cold-formed metal framing.

### 3.3 GLASS-MAT GYPSUM SHEATHING INSTALLATION

- A. Comply with GA-253 and with manufacturer's written instructions.
1. Fasten glass-mat gypsum sheathing to cold-formed metal framing with screws.
- B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.
- C. Vertical Installation: Install vertical edges centered over studs. Abut ends and edges with those of adjacent panels. Attach at perimeter and within field of panel to each stud.
1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of panels.
- D. Seal sheathing joints according to sheathing manufacturer's written instructions.
1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
  2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

**END OF SECTION 06 16 00**

## SECTION 06 41 16

### PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:

- 1. Plastic-laminate-faced architectural cabinets.
- 2. Wood furring, blocking, shims, and hanging strips for installing plastic-laminate-faced architectural cabinets unless concealed within other construction before cabinet installation.

- B. Related Requirements:

- 1. Section 06 10 53 "Miscellaneous Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing cabinets and concealed within other construction before cabinet installation.
- 2. Section 12 36 23.13 "Plastic-Laminate-Clad Countertops."

##### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

- 1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product, including panel products, high-pressure decorative laminate, adhesive for bonding plastic laminate, fire-retardant-treated materials, and cabinet hardware and accessories.

- 1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- 2. Include copies of warranties from chemical-treatment manufacturers for each type of treatment.
- 3. For composite wood products used on the interior of the building, indicate that product contains no added urea formaldehyde resins.

- B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
  - 1. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
  - 2. Show locations and sizes of cutouts and holes for electrical switches and outlets and other items installed in architectural plastic-laminate cabinets.
- C. Samples:
  - 1. Plastic laminates, for each color, pattern, and surface finish.
  - 2. Thermoset decorative panels, for each color, pattern, and surface finish.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and fabricator.
- B. Product Certificates: For each type of product.
- C. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.

#### 1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
- B. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver cabinets until painting and similar operations that could damage woodwork have been completed in installation areas. If cabinets must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

#### 1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
  - 1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed, and indicate measurements on Shop Drawings.

- C. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

## 1.9 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that cabinets can be supported and installed as indicated.

## PART 2 - PRODUCTS

### 2.1 PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of architectural plastic-laminate cabinets indicated for construction, finishes, installation, and other requirements.
  - 1. The Contract Documents contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with those selections and requirements in addition to the quality standard.
- B. Grade: Custom.
- C. Type of Construction: Frameless.
- D. Cabinet, Door, and Drawer Front Interface Style: Flush overlay.
- E. Reveal Dimension: 1/2 inch.
- F. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by woodwork quality standard.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following, or equal approved by Professional:
    - a. Abet Laminati Inc.
    - b. Formica Corporation.
    - c. Lamin-Art, Inc.
    - d. Pionite; a Panolam Industries International, Inc. brand.
    - e. Wilsonart LLC.
- G. Laminate Cladding for Exposed Surfaces:
  - 1. Horizontal Surfaces: Grade HGS.
  - 2. Postformed Surfaces: Grade HGP.
  - 3. Vertical Surfaces: Grade HGS.
  - 4. Edges: Grade HGS
  - 5. Pattern Direction: Vertically for drawer fronts, doors, and fixed panels.
- H. Materials for Semiexposed Surfaces:



1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, NEMA LD 3, Grade VGS.
    - a. Edges of Plastic-Laminate Shelves: PVC edge banding, 0.12 inch thick, matching laminate in color, pattern, and finish.
    - b. Edges of Thermoset Decorative Panel Shelves: PVC or polyester edge banding.
    - c. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, NEMA LD 3, Grade VGS.
  2. Drawer Sides and Backs: Thermoset decorative panels with PVC or polyester edge banding.
  3. Drawer Bottoms: Thermoset decorative panels.
- I. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.
  - J. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
  - K. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
    1. As indicated on Drawings by laminate manufacturer's designations.

## 2.2 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.
  1. Wood Moisture Content: 5 to 10 percent.
- B. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.
  1. Low-Emitting Composite Wood Products: Composite wood products used on the interior of the building must contain no added urea formaldehyde resins.
  2. Medium-Density Fiberboard: ANSI A208.2, Grade 130.
  3. Particleboard: ANSI A208.1, Grade M-2.
  4. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1.
  5. Thermoset Decorative Panels: Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for test methods 3.3, 3.4, 3.6, 3.8, and 3.10.

## 2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated on Drawings or where required by codes adopted by authorities having jurisdiction, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
  1. Use treated materials that comply with requirements of referenced woodworking standard. Do not use materials that are warped, discolored, or otherwise defective.

2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
  3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.
- B. Fire-Retardant-Treated Lumber and Plywood: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
1. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent, respectively.
  2. Mill lumber before treatment and implement special procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.
- C. Fire-Retardant Particleboard: Panels complying with the following requirements, made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less per ASTM E 84.
1. For panels 3/4 inch thick and less, comply with ANSI A208.1 for Grade M-2 except for the following minimum properties: modulus of rupture, 1600 psi; modulus of elasticity, 300,000 psi; internal bond, 80 psi; and screw-holding capacity on face and edge, 250 and 225 lbf, respectively.
- D. Fire-Retardant Fiberboard: Medium-density fiberboard panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less per ASTM E 84.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Panel Source International, Inc.; Pyroblock Platinum.
    - b. SierraPine; Medite FR.

## 2.4 CABINET HARDWARE AND ACCESSORIES

- A. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 135 degrees of opening, self-closing.
- B. Back-Mounted Pulls: BHMA A156.9, B02011.
- C. Wire Pulls: Back mounted, solid metal, 5 inches long, 2-1/2 inches deep, and 5/16 inch in diameter.
- D. Catches: Push-in magnetic catches, BHMA A156.9, B03131.
- E. Shelf Rests: BHMA A156.9, B04013; metal, two-pin type with shelf hold-down clip.

- F. Drawer Slides: BHMA A156.9.
  - 1. Grade 1 and Grade 2: Side mounted and extending under bottom edge of drawer; full-extension type; zinc-plated steel with polymer rollers.
  - 2. Grade 1HD-100 and Grade 1HD-200: Side mounted; full-extension type; zinc-plated-steel ball-bearing slides.
  - 3. For drawers not more than 3 inches high and not more than 24 inches wide, provide Grade 1.
  - 4. For drawers more than 3 inches high but not more than 6 inches high and not more than 24 inches wide, provide Grade 1.
  - 5. For drawers more than 6 inches high or more than 24 inches wide, provide Grade 1HD-100.
  - 6. For computer keyboard shelves, provide Grade 1.
- G. Aluminum Slides for Sliding Glass Doors: BHMA A156.9, B07063.
- H. Door Locks: BHMA A156.11, E07121.
- I. Drawer Locks: BHMA A156.11, E07041.
- J. Door and Drawer Silencers: BHMA A156.16, L03011.
- K. Tempered Float Glass for Cabinet Doors: ASTM C 1048, Kind FT, Condition A, Type I, Class 1 (clear), Quality-Q3, with exposed edges seamed before tempering 6 mm thick unless otherwise indicated.
- L. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
  - 1. Satin Stainless Steel: BHMA 630.
- M. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

## 2.5 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.
- C. Adhesives: Do not use adhesives that contain urea formaldehyde.
- D. Adhesive for Bonding Plastic Laminate: Unpigmented contact cement.
  - 1. Adhesive for Bonding Edges: Hot-melt adhesive.

## 2.6 FABRICATION

- A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.

- B. Fabricate cabinets to dimensions, profiles, and details indicated.
- C. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
  - 1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.
- D. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
- E. Install glass to comply with applicable requirements in Section 08 80 00 "Glazing" and in GANA's "Glazing Manual." For glass in wood frames, secure glass with removable stops.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Before installation, condition cabinets to average prevailing humidity conditions in installation areas.
- B. Before installing cabinets, examine shop-fabricated work for completion and complete work as required.

#### **3.2 INSTALLATION**

- A. Grade: Install cabinets to comply with same grade as item to be installed.
- B. Install cabinets level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.
- C. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- D. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork.
  - 1. Use filler matching finish of items being installed.
- E. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
  - 1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.

2. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish.

### 3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean cabinets on exposed and semiexposed surfaces.

**END OF SECTION 06 41 16**

## SECTION 07 05 43

### RAIN SCREEN ATTACHMENT SYSTEMS

#### PART 1 – GENERAL

##### 1.0 STIPULATIONS

- A. The specifications sections “General Conditions to the Construction Contract”, “Special Conditions” and “Division 01 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.1 SUMMARY

- A. Provide a non-continuous, aluminum rain screen attachment system for attachment of various siding types, installed in conjunction with exterior insulation. System shall be designed to incorporate flashing components, drainage components, and air barriers in such a way that the system will properly perform.

##### 1.2 RELATED SECTIONS

- A. Section 05 40 00 – Cold-Formed Metal Framing
- B. Section 06 10 00 – Rough Carpentry
- C. Section 06 16 00 – Sheathing
- D. Section 07 21 00 – Thermal Insulation
- E. Section 07 27 00 – Air Barriers
- F. Section 07 42 00 – Wall Panels
- G. Section 07 62 00 – Sheet Metal Flashing and Trim

##### 1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM) Publications:
  - 1. ASTM E330 – Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
  - 2. ASTM E331 – Test Method for Water Penetration of Exterior Windows
- B. American Society of Civil Engineers (ASCE) Publications:
  - 1. ASCE 7 – Minimum Design Loads for Buildings and Other Structures
- C. European Standards: DIN 4102 – Building Material Class – Germany
- D. IBC 1403.2: Reference Standard for Selection of Weather Resistive Barriers
- E. AAMA 509: Test and Classification Method for Drained and Back-Ventilated Rain Screen Wall Cladding Systems

##### 1.3 SYSTEM DESCRIPTION

A. System assembly shall include the following components from the substrate out:

1. Substrate: Wall framing assembly and sheathing
2. Weather Resistant/Air Barrier over substrate
3. Exterior Insulation
4. Non-continuous aluminum rain screen attachment system
5. Exterior cladding

B. Design Requirements

1. Provide, in conjunction with wall substrate and air barrier, a weather tight wall assembly utilizing rain screen principle
2. Manufacturer is responsible for designing system, including anchorage to structural system.
3. Design modifications shall be provided only as necessary to satisfy as built conditions and to meet performance requirements.
4. Employ registered professional engineer, licensed to practice engineering in jurisdiction where project is located, to engineer each component of rain screen attachment system.

#### 1.4 PERFORMANCE REQUIREMENTS

A. Thermal Performance

1. Attachment system must be thermally modeled to demonstrate, at minimum, a compliance with ANSI/ASHRAE 90.1-2010 maximum U-Value for walls
2. Continuous framing profiles (including C- or Z-shaped sections or furring) penetrating insulation are not permitted

B. Design Loads

1. System shall be optimized based on design loads
2. Maximum panel deflection: 1/300 of span or less of span when tested in accordance with positive and negative pressures and as required to prevent cracking or damage to panel facing
3. Comply with applicable seismic requirements for Project location
4. Adequately resist wind forces and uplift for Project location with minimum of 90 MPH for wall surface and 90 MPH for parapet and corner panels tested in accordance with ASTM E330
5. Accommodate movement of cladding components without undue stress on fasteners or other detrimental effects, when subjected to seasonal temperature range of :
  - a. Ambient: 120 degrees F
  - b. Cladding surface: 180 degrees F
6. Accommodate tolerances of support structure
7. Condensation: System shall accommodate positive drainage for moisture entering or condensation occurring within panel system.
8. Flatness: System shall be flat with no noticeable warpage, buckling, deflections or other surface irregularities

#### 1.5 SUBMITTALS

A. Refer to Section 01 33 00 – Submittal Procedures

- B. Product data information describing materials and fabrication for aluminum rain screen attachment system.
- C. Product Data: For products having recycled content, indicate percentages by weight of postconsumer and pre-consumer recycled content.
- D. Shop Drawings: Submit detailed shop drawings showing:
  - 1. Location, layout, and dimensions of panels, including special pieces and trim
  - 2. Locations of fixed and sliding fastening points
  - 3. Details at top, bottom, corner, windows, doors, etc.
  - 4. Installation details: attachment methods, fasteners, joints, corners, openings, intersections with adjacent materials, flashings, closures, trim and other critical conditions
- E. Copy of written approval by perimeter fastener supplier of the use of selected screws confirming use in a rainscreen wall assembly.
- F. Laboratory Test Reports: For primers installed in the building interior, documentation indicating that products meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Small-Scale Environmental Chambers."
- G. Engineering Calculations: Submit engineering calculations as required by local building code
- H. Samples
  - 1. 3 inches minimum length of attachment profile
  - 2. Typical anchor brackets and fasteners
- I. Provide manufacturer's sample warranty, installation, and maintenance instructions

## 1.6 QUALITY ASSURANCE

- A. System Manufacturer's Qualifications: Provide exterior wall system manufactured by a firm with minimum 15 years' experience in the production of systems that are similar to those indicated for this project
- B. Installer Qualifications: Company experienced in installing rain screen systems and acceptable to Rain Screen Attachment System supplier.
- C. Attachment details shall be designed under direct supervision of licensed professional structural engineer. Calculations and shop drawings shall bear seal of supervising engineer.

## 1.7 QUALITY CONTROL

- A. Single Source Responsibility: Furnish engineered rain screen attachment system components under direct responsibility of single manufacturer
- B. Field Measurements: Verify actual supporting and adjoining construction before fabrication. Record measurements on project record shop drawings.
- C. Established Dimensions: Where field measurements cannot be made without delaying work, guarantee dimensions and proceed with fabrication of rain screen attachment system corresponding to established dimensions.



## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Prior to shipping, pack and crate system components to prevent damage during transit and storage.
- B. Deliver materials and components in manufacturer's original, unopened, and undamaged containers or bundles, full identified. Exercise care to avoid damage during unloading, storing and installation
- C. Inspect aluminum attachment components immediately upon delivery at site. Notify manufacturer of damage.
- D. Follow manufacturer's instruction for storage of product. Keep pieces in original packing material until ready to install.

## 1.9 WARRANTY

- A. Ten Year Warranty: Provide manufacturer's written warranty for aluminum rain screen attachment system to cover repair and replacement of defective components

## **PART 2 – PRODUCTS**

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide ECO Cladding, Alpha Vci.10 Aluminum Rail Screen Attachment System with non-continuous, self-shimming bracket and rail assembly to accommodate out of plumb conditions or comparable product by one of the following:
  - 1. ECO CLADDING.
  - 2. Knight MFI System
  - 3. Sika Tack Panel Rainscreen Attachment System
  - 4. Equal approved by Professional.

### 2.2 PRODUCT REQUIREMENTS

- A. Provide all rain screen attachment system components from a single source
- B. Materials
  - 1. Bracket and rail components
    - a. Made from 6000 series architectural grade aluminum
    - b. Finish: Anodized or powder coat, black.
    - c. Brackets shall be self-shimming for out of plumb conditions, with at least 1½" of built in adjustability
  - 2. Sub-Framing:
    - a. 1" extruded aluminum.
    - b. Using hat or zee from ECO Cladding, Hci system.
    - c. Finish: Anodized or powder coat, black.
  - 3. Fasteners
    - d. Minimum 304 series stainless steel fasteners and anchors of type, size and spacing required for type of substrate and Project conditions, to meet performance requirements specified in Paragraph 1.4 and as indicated in design calculations and shop drawings
  - 4. The following characteristics are not acceptable:

- a. Continuous framing profiles (including C- or Z-shaped sections or furring) penetrating insulation
- b. Components made from galvanized steel, galvalume, or other carbon based metals
- c. Components made from FRP or fiberglass materials

### 2.3 EXTERIOR INSULATION

- A. Refer to Section 07 21 00 – Thermal Insulation

### 2.4 SIDING/RAIN SCREEN PANEL

- A. Refer to Division 7 Sections applicable to project.

## **PART 3 – EXECUTION**

### 3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of rainscreen cladding
- B. Do not proceed with cladding installation until deficiencies have been addressed

### 3.2 RAIN SCREEN ATTACHMENT SYSTEM INSTALLATION

- A. Install rain screen attachment system in accordance with manufacturer's instructions and approved shop drawings
- B. Establish level lines for panel coursing and positioning of Alpha Vci brackets and support rail
- C. Attach Alpha Vci brackets with engineered fasteners to accomplish performance requirements specified in Paragraph 1.4
- D. Attach vertical support rails with engineered fasteners to accomplish performance requirements specified in Paragraph 1.4
  - a. Provide 1/2"- 1" space between end of adjacent profiles
- E. Install exterior insulation to fit between wall brackets as specified by Section 07 21 00.

### 3.3 QUALITY CONTROL

- A. The installing contractor shall perform daily inspections to maintain and confirm that tolerances are being met and that manufacturer's instructions are complied with
- B. The owner may engage a third party inspection agency to verify that installed rain screen attachment system meets performance requirements and tolerances

### 3.4 CLEANING AND PROTECTION

- A. Remove and replace damaged, bowed, or bent pieces of aluminum
- B. Immediately after installing, wipe down work. Do not use wire brushes, metallic tools, or abrasives for cleaning.
- C. Without damaging completed work, provide protective boards at exposed external corners which may be damaged by construction activities

**END OF SECTION 07 05 43**

## SECTION 07 13 26

### SELF-ADHERING SHEET WATERPROOFING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section includes self-adhering modified bituminous sheet waterproofing of exterior walls below grade.
- B. Related Requirements:
  - 1. Section 07 21 00 "Thermal Insulation" for foam-plastic board insulation used to insulate foundation walls.
  - 2. Section 09 30 13 "Ceramic Tiling" for waterproofing membranes installed beneath tiling.

##### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.
  - 2. Review waterproofing requirements including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
  - 2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.
- B. Shop Drawings: Show locations and extent of waterproofing and details of substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Field quality-control reports.
- C. Sample warranties.

## 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.

## 1.7 FIELD CONDITIONS

- A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.
  - 1. Do not apply waterproofing in snow, rain, fog, or mist.
- B. Maintain adequate ventilation during preparation and application of waterproofing materials.

## 1.8 WARRANTY

- A. Manufacturer's Warranty: Manufacturer's standard materials-only warranty in which manufacturer agrees to furnish replacement waterproofing material for waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.
  - 1. Warranty Period: Five (5) years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### 2.1 MATERIALS, GENERAL

- A. Source Limitations for Waterproofing System: Obtain waterproofing materials and molded-sheet drainage panels from single source from single manufacturer.

### 2.2 MODIFIED BITUMINOUS SHEET WATERPROOFING

- A. Modified Bituminous Sheet: Minimum 60-mil nominal thickness, self-adhering sheet consisting of 56 mils of rubberized asphalt laminated on one side to a 4-mil- thick, polyethylene-film reinforcement, and with release liner on adhesive side; formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction.
  - 1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by the Professional:
    - a. Carlisle Coatings & Waterproofing Inc.; CCW MiraDRI 860/861.

- b. CETCO Building Materials Group, a subsidiary of AMCOL International Corp.; EnviroSheet.
- c. Henry Company; Blueskin WP 100/200.
- d. Meadows, W.R., Inc.; SealTight Mel-Rol.
- e. Polyguard Products, Inc.; Polyguard 650.

2. Physical Properties:

- a. Tensile Strength, Membrane: 325 psi minimum; ASTM D 412, Die C, modified.
- b. Ultimate Elongation: 300 percent minimum; ASTM D 412, Die C, modified.
- c. Low-Temperature Flexibility: Pass at minus 20 deg F; ASTM D 1970.
- d. Crack Cycling: Unaffected after 100 cycles of 1/8-inch movement; ASTM C 836.
- e. Puncture Resistance: 50 lbf minimum; ASTM E 154.
- f. Water Absorption: 0.1 percent weight-gain maximum after 48-hour immersion at 70 deg F; ASTM D 570.
- g. Water Vapor Permeance: 0.05 perms maximum; ASTM E 96/E 96M, Water Method.
- h. Hydrostatic-Head Resistance: 200 feet minimum; ASTM D 5385.

3. Sheet Strips: Self-adhering, rubberized-asphalt strips of same material and thickness as sheet waterproofing.

### 2.3 AUXILIARY MATERIALS

- A. General: Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.
  - 1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.
- B. Primer: Low VOC primer recommended for substrate by sheet-waterproofing material manufacturer.
- C. Surface Conditioner: Liquid, waterborne surface conditioner recommended for substrate by sheet-waterproofing material manufacturer.
- D. Liquid Membrane: Elastomeric, two-component liquid, cold fluid applied, of trowel grade or low viscosity.
- E. Substrate Patching Membrane: Low-viscosity, two-component, modified asphalt coating.
- F. Metal Termination Bars: Aluminum bars, approximately 1 by 1/8 inch thick, predrilled at 9-inch centers.
- G. Protection Course: Molded-polystyrene board insulation, ASTM C 578, Type I, 0.90-lb/cu. ft. minimum density, 1-1/2 inch minimum thickness.

### 2.4 MOLDED-SHEET DRAINAGE PANELS

- A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Composite subsurface drainage panel consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding

No. 70 sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a vertical flow rate of 9 to 15 gpm per ft.

1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by the Professional:
  - a. American Hydrotech, Inc.; Hydrodrain 420.
  - b. Carlisle Coatings & Waterproofing Inc.; CCW MiraDRAIN 6200.
  - c. Grace Construction Products; W.R. Grace & Co. -- Conn.; Hydroduct 220.

## 2.5 GEOTEXTILE FILTER FABRICS

- A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. when tested according to ASTM D 4491.
- B. Structure Type: Nonwoven, needle-punched continuous filament.
  1. Survivability: AASHTO M 288 Class 2.
  2. Styles: Flat and sock.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the waterproofing.
  1. Verify that concrete has cured and aged for minimum time period recommended in writing by waterproofing manufacturer.
  2. Verify that substrate is visibly dry and within the moisture limits recommended in writing by manufacturer. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 SURFACE PREPARATION

- A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.
- B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.
- E. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D 4258.

1. Install sheet strips of width according to manufacturer's written instructions and center over treated construction and contraction joints and cracks exceeding a width of 1/16 inch.
- F. Bridge and cover isolation joints and expansion joints with overlapping sheet strips of widths according to manufacturer's written instructions.
1. Invert and loosely lay first sheet strip over center of joint. Firmly adhere second sheet strip to first and overlap to substrate.
- G. Corners: Prepare, prime, and treat inside and outside corners according to ASTM D 6135.
1. Install membrane strips centered over vertical inside corners. Install 3/4-inch fillets of liquid membrane on horizontal inside corners and as follows:
    - a. At footing-to-wall intersections, extend liquid membrane in each direction from corner or install membrane strip centered over corner.
- H. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions according to ASTM D 6135.

### 3.3 MODIFIED BITUMINOUS SHEET-WATERPROOFING APPLICATION

- A. Install modified bituminous sheets according to waterproofing manufacturer's written instructions and recommendations in ASTM D 6135.
- B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Reprime areas exposed for more than 24 hours.
- C. Apply and firmly adhere sheets over area to receive waterproofing. Accurately align sheets and maintain uniform 2-1/2-inch- minimum lap widths and end laps. Overlap and seal seams, and stagger end laps to ensure watertight installation.
1. When ambient and substrate temperatures range between 25 and 40 deg F, install self-adhering, modified bituminous sheets produced for low-temperature application. Do not use low-temperature sheets if ambient or substrate temperature is higher than 60 deg F.
- D. Apply continuous sheets over already-installed sheet strips, bridging substrate cracks, construction, and contraction joints.
- E. Seal edges of sheet-waterproofing terminations with mastic.
- F. Install sheet-waterproofing and auxiliary materials to tie into adjacent waterproofing.
- G. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending 6 inches beyond repaired areas in all directions.
- H. Immediately install protection course with butted joints over waterproofing membrane.



### 3.4 MOLDED-SHEET DRAINAGE-PANEL INSTALLATION

- A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, according to manufacturer's written instructions. Use adhesives or other methods that do not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.
  - 1. For vertical applications, install protection course before installing drainage panels.

### 3.5 INSTALLATION OF FILTER FABRIC AT FOUNDATION DRAINS

- A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches deep and 12 inches wide.
- B. Lay flat-style geotextile fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.
- D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.
- E. Install drainage piping as indicated in Section 33 46 00 "Subdrainage."
- F. Add drainage course to width of at least 6 inches on side away from wall and to top of pipe.
- G. After satisfactory testing of foundation drain pipes, cover piping to width of at least 6 inches on side away from footing and above top of pipe to within 12 inches of finish grade.
- H. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
- I. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches.

### 3.6 FIELD QUALITY CONTROL

- A. Owner will engage a site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components, and to furnish daily reports to Architect.
- B. Prepare test and inspection reports.

### 3.7 PROTECTION, REPAIR, AND CLEANING

- A. Protect waterproofing from damage and wear during remainder of construction period.
- B. Protect installed board insulation protection course from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

- C. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.
- D. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

**END OF SECTION 07 13 26**

## SECTION 07 17 00

### BENTONITE WATERPROOFING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:

- 1. Bentonite waterproofing.
- 2. Molded-sheet drainage panels.
- 3. Insulation drainage panels.

- B. Related Requirements:

- 1. Section 31 20 00 "Earth Moving" for excavating and backfilling.
- 2. Section 31 50 00 "Excavation Support and Protection" for permanent below-grade support systems that receive blind-side waterproofing.

##### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

- 1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Shop Drawings: Include installation details for waterproofing, penetrations, and interface with other work.

##### 1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of waterproofing material.

- B. Field quality-control reports.

- C. Sample Warranty: For manufacturer's special warranty.

## 1.6 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit bentonite waterproofing to be installed according to manufacturer's written instructions and warranty requirements.
1. Do not apply waterproofing materials to surfaces where ice or frost is visible. Do not apply bentonite waterproofing materials in areas with standing water.
  2. Do not place bentonite clay products in on damp surfaces unless such practice is approved in writing by manufacturer.

## 1.7 WARRANTY

- A. Special Warranty: Manufacturer and Installer agree(s) to repair or replace components of bentonite waterproofing system that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Ten (10) years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 GEOTEXTILE/BENTONITE SHEETS

- A. Regular Geotextile/Bentonite Sheet: Minimum of 1.0 lb/sq. ft. of bentonite clay granules between two layers of polypropylene geotextile fabric, one woven and one nonwoven, needle punched and heat fused together.
1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by Professional:
    - a. Carlisle Coatings & Waterproofing; CCW MiraCLAY.
    - b. CETCO, a subsidiary of AMCOL International Corp; Voltex.
  2. Grab Tensile Strength: 95 lbf according to ASTM D 4632.
  3. Puncture Resistance: 100 lbf according to ASTM D 4833.
- B. Polyethylene-Lined Geotextile/Bentonite Sheet: Minimum of 1.0 lb/sq. ft. of bentonite clay granules between two layers of geotextile fabric, heat-fused together; and with a low-permeability polyethylene geomembrane bonded to one surface.
1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by Professional:
    - a. Carlisle Coatings & Waterproofing; CCW MiraCLAY GM.
    - b. CETCO, a subsidiary of AMCOL International Corp; Voltex DS.
  2. Grab Tensile Strength: 95 lbf according to ASTM D 4632.
  3. Puncture Resistance: 100 lbf according to ASTM D 4833.
  4. Vapor Permeance: 0.03 perms according to ASTM E 96/E 96M.

## 2.2 COMPOSITE POLYETHYLENE/BENTONITE MEMBRANE

- A. Composite Polyethylene/Bentonite Membrane: Minimum **[90-mil-]** **<Insert dimension>** thick membrane consisting of a polyethylene geomembrane bonded to a layer of bentonite.
1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by Professional:
    - a. CETCO, a subsidiary of AMCOL International Corp; Swelltite.
    - b. Tremco Commercial Sealants & Waterproofing, an RPM company; Paraseal or Paraseal W/GM.
  2. Puncture Resistance: 70 lbf according to ASTM D 4833 or 169 lbf according to ASTM E 154.
  3. Vapor Permeance: 0.03 perms according to ASTM E 96/E 96M.
- B. Composite Polyethylene/Bentonite Membrane with Protective Facing: Minimum 170-mil-thick membrane consisting of polyethylene geomembrane bonded to a layer of bentonite and with a protective, nonwoven-geotextile facing.
1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by Professional:
    - a. CETCO, a subsidiary of AMCOL International Corp; Volclay Ultraseal SP.
    - b. Tremco Commercial Sealants & Waterproofing, an RPM company; Paraseal LG or Paraseal W/GM/LG.
  2. Puncture Resistance: 130 lbf according to ASTM D 4833 or 169 lbf according to ASTM E 154.
  3. Vapor Permeance: 0.03 perms according to ASTM E 96/E 96M.

## 2.3 PROTECTION COURSE

- A. Protection Course: Protection mat of type and thickness as recommended in writing by waterproofing manufacturer for each Project condition.
1. Adhesive: As recommended in writing by waterproofing manufacturer.

## 2.4 MOLDED-SHEET DRAINAGE PANELS

- A. Nonwoven-Geotextile-Faced Molded-Sheet Drainage Panels: Composite subsurface drainage panel consisting of studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 sieve laminated to one side of the core, with[ **or without**] a polymeric film bonded to the other side; and with a vertical flow rate of 9 to 18 gpm per ft.
- B. Woven-Geotextile-Faced Molded-Sheet Drainage Panels: Composite subsurface drainage panel consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a woven-geotextile facing with an apparent opening size not exceeding No. 40 sieve, laminated to one side of the core, with[ **or without**] a polymeric film bonded to the other side; and with a horizontal flow rate of not less than 2.8 gpm per ft.

## 2.5 ACCESSORIES

- A. General: Manufacturer's standard accessories recommended for intended use and compatible with bentonite waterproofing.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate preparations and other conditions affecting performance of bentonite waterproofing.
- B. Examine bentonite materials before installation. Reject materials that have been prematurely exposed to moisture.
- C. Verify that substrate is complete and that work that will penetrate waterproofing is complete and rigidly installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Clean, prepare, and treat substrates according to manufacturer's written instructions.
- B. Formed Concrete Surfaces: Remove fins and projections. Fill voids, rock pockets, form-tie holes, and other defects with bentonite mastic or cement grout patching material according to manufacturer's written instructions.
- C. Horizontal Concrete Surfaces: Remove debris, standing water, oily substances, mud, and similar substances that could impair the bonding ability of concrete or the effectiveness of waterproofing. Fill voids, cracks greater than 1/8 inch, honeycomb areas, and other defects with bentonite mastic or cement grout patching material according to manufacturer's written instructions.
- D. Excavation Support and Protection System: If water is seeping, use plastic protection sheets or other suitable means to prevent wetting the bentonite waterproofing. Fill minor gaps and spaces 1/8 inch wide or wider with wood, metal, concrete, or other appropriate filling material. Cover or fill large voids and crevices with cement mortar according to manufacturer's written instructions.

### 3.3 INSTALLATION, GENERAL

- A. Prepare substrates, voids, cracks, and cavities; and install waterproofing and accessories according to manufacturer's written instructions.
- B. Protect waterproofing from damage and wetting before and during subsequent construction operations. Repair punctures, tears, and cuts.
- C. Install protection course before backfilling or placing overburden when recommended in writing by waterproofing manufacturer.

### 3.4 GEOTEXTILE/BENTONITE SHEET INSTALLATION

- A. Install a continuous layer of waterproofing sheets directly against surface to be waterproofed. Lap ends and edges a minimum of 4 inches on horizontal and vertical substrates unless otherwise indicated. Stagger end joints between sheets a minimum of 24 inches. Fasten seams by stapling to adjacent sheet or nailing to substrate.
- B. Below Structural Slabs-on-Grade: Place waterproofing sheets on compacted substrate with ends and edges lapped and stapled.
  - 1. Install a layer of waterproofing sheets under footings, grade beams, and pile caps; or continue waterproofing through key joints between footings and foundation walls, and extend a minimum of 8 inches up or beyond perimeter slab forms.
- C. Concrete Walls: Starting at bottom of wall, apply waterproofing sheets horizontally against wall. Secure with masonry fasteners spaced according to manufacturer's written instructions. Extend to bottom of footing, grade beam, or wall, and secure.
  - 1. Termination at Grade: Fasten top edge of waterproofing sheets to wall and protect top edge with sheet metal counterflashing. Cover waterproofing with a lapped course of plastic protection sheets if backfilling does not proceed immediately.
- D. Excavation Support and Protection (Permanent Shoring): Encase tieback heads, rods, nuts, and plates according to waterproofing manufacturer's written instructions for each configuration.
  - 1. Install a layer of waterproofing sheets, with ends and edges lapped and nailed to shoring. Cover waterproofing with plastic protection sheets if needed for protection from precipitation; remove plastic sheets before placing concrete.
  - 2. Inspect and repair waterproofing after reinforcing steel has been placed. Coordinate and control concrete placement to avoid damage to waterproofing.

### 3.5 COMPOSITE POLYETHYLENE/BENTONITE MEMBRANE INSTALLATION

- A. Install a continuous layer of waterproofing membrane, with ends and edges lapped a minimum of 4 inches unless otherwise indicated. Stagger end joints between membranes a minimum of 24 inches. Seal joints with permanent seam tape.
- B. Below Structural Slabs-on-Grade: Apply waterproofing membrane with polyethylene side down, and staple ends and edges.
  - 1. Install under footings, grade beams, and pile caps; or continue waterproofing through key joints between footings and foundation walls, and extend a minimum of 8 inches up or beyond perimeter slab forms.
  - 2. Protect waterproofing from damage caused by reinforcing bar supports with sharp edges.
- C. Slabs: Starting at lowest point, install a continuous layer of waterproofing membrane, with ends and edges lapped a minimum of 4 inches.
- D. Concrete Walls: Apply mastic to form continuous 3/4-inch cant or fillet at intersection of footings and walls.
  - 1. Starting at lowest point, install a layer of waterproofing membrane horizontally, extending a minimum of 6 inches onto the footing. Lap membrane ends and edges a minimum of 2 inches.
  - 2. Secure membrane to wall.

3. Apply mastic to form continuous 3/4-inch layer around penetrations.
  4. Termination at Grade: Extend waterproofing membrane to within 12 inches of finish grade unless otherwise indicated. Secure top edge with termination bar. Apply sealant to top edge of termination bar.
- E. Excavation Support and Protection (Permanent Shoring): Cut, clean, and treat tiebacks and similar projections. Encase tieback heads, rods, nuts, and plates according to waterproofing manufacturer's written instructions for each configuration. If water is present, cover shoring and lagging with plastic protection sheets; remove plastic sheets before placing concrete.
1. Starting at lowest point, install a layer of waterproofing membrane, with ends and edges lapped minimum of 4 inches and nailed to shoring.
  2. Inspect and repair waterproofing membrane after reinforcing steel has been placed. Coordinate and control concrete placement to avoid damage to waterproofing.

### 3.6 MOLDED-SHEET DRAINAGE PANEL INSTALLATION

- A. Place and secure molded-sheet drainage panels according to manufacturer's written instructions. Use adhesives or another method that does not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.
1. For vertical applications, install protection course before installing drainage panels.

### 3.7 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed waterproofing installation before covering with other construction, and provide written report stating that installation complies with manufacturer's written instructions.
1. Remove and replace applications of bentonite waterproofing where inspection indicates that it does not comply with specified requirements.

**END OF SECTION 07 17 00**



**SECTION 07 21 00**  
**THERMAL INSULATION**

**PART 1 - GENERAL**

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

- A. Section Includes:
  - 1. Foam-plastic board insulation.
  - 2. Glass-fiber blanket insulation.
  - 3. Vapor retarders.
- B. Related Requirements:
  - 1. Section 04 20 00 "Unit Masonry" for insulation installed in cavity walls.
  - 2. Section 07 13 26 "Self-Adhering Sheet Waterproofing" for insulation board and insulated drainage panels installed with waterproofing.
  - 3. Section 07 54 23 "Thermoplastic Polyolefin (TPO) Roofing" for insulation specified as part of roofing construction.
  - 4. Section 07 84 46 "Fire-Resistive Joint Systems" for insulation installed as part of a perimeter fire-resistive joint system.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.
- B. Research/Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.5 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect foam-plastic board insulation as follows:
  - 1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
  - 2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site before installation time.
  - 3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

## PART 2 - PRODUCTS

### 2.1 FOAM-PLASTIC BOARD INSULATION

- A. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and minimum compressive strength indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by Professional:
    - a. DiversiFoam Products.
    - b. Dow Chemical Company (The).
    - c. Owens Corning.
    - d. Pactiv Building Products.
  - 2. Type X, 15 psi at cavity walls.
  - 3. Type IV, 25 psi at foundation perimeter.
- B. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

### 2.2 GLASS-FIBER BLANKET INSULATION

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by the Professional:
  - 1. CertainTeed Corporation.
  - 2. Johns Manville.
  - 3. Knauf Insulation.
  - 4. Owens Corning.
- B. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.
  - 1. Locations: Sound attenuation insulation; insulation as shown in interior wall/partition assemblies and floor/ceiling assemblies.
- C. Reinforced-Foil-Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type III (reflective faced), Class A (faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier), faced with foil scrim, foil-scrim kraft, or foil-scrim polyethylene.
  - 1. Locations: Exterior framed wall assemblies.

2. Thickness as required to provide the following:
  - a. Minimum R-value of R-19 in 2 x 6 walls.
- D. Sustainability Requirements: Provide glass-fiber blanket insulation as follows:
  1. Free of Formaldehyde: Insulation manufactured with 100 percent acrylic binders and no formaldehyde.
  2. Low Emitting: Insulation tested according to ASTM D 5116 and shown to emit less than 0.05-ppm formaldehyde.

### 2.3 VAPOR RETARDERS

- A. Polyethylene Vapor Retarders: ASTM D 4397, 10 mils thick, with maximum permeance rating of 0.13 perm.
- B. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

### 2.4 INSULATION FASTENERS

- A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position indicated with self-locking washer in place.
  1. Products: Subject to compliance with requirements, provide one of the following, but are not limited to, the following, or equal approved by the Professional:
    - a. AGM Industries, Inc.; Series T TACTOO Insul-Hangers.
    - b. Gemco; Spindle Type.
  2. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
  3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation indicated.
- B. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.
  1. Products: Subject to compliance with requirements, provide one of the following, but are not limited to, the following, or equal approved by the Professional:
    - a. AGM Industries, Inc.; RC150.
    - b. Gemco; R-150.
- C. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.
  1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following, or equal approved by the Professional:
    - a. AGM Industries, Inc.; TACTOO Adhesive.
    - b. Gemco; Tuff Bond Hanger Adhesive.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Clean substrates of substances that are harmful to insulation or vapor retarders, including removing projections capable of puncturing vapor retarders, or that interfere with insulation attachment.

### **3.2 INSTALLATION, GENERAL**

- A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

### **3.3 INSTALLATION OF BELOW-GRADE INSULATION**

- A. On vertical surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.
  - 1. If not otherwise indicated, extend insulation a minimum of 24 inches below exterior grade line.
- B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.
  - 1. If not otherwise indicated, extend insulation a minimum of 24 inches in from exterior walls.

### **3.4 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION**

- A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
- B. Foam-Plastic Board Insulation: Seal joints between units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.
- C. Glass-Fiber or Mineral-Wool Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
  - 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
  - 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.

3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
5. Vapor-Retarder-Faced Blankets: Tape joints and ruptures in vapor-retarder facings, and seal each continuous area of insulation to ensure airtight installation.
  - a. Exterior Walls: Set units with facing placed toward interior of construction.

### 3.5 INSTALLATION OF INSULATION FOR CONCRETE SUBSTRATES

- A. Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:
  1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application indicated.
  2. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.
  3. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

### 3.6 INSTALLATION OF VAPOR RETARDERS

- A. Place vapor retarders on side of construction indicated on Drawings. Extend vapor retarders to extremities of areas to protect from vapor transmission. Secure vapor retarders in place with adhesives or other anchorage system as indicated. Extend vapor retarders to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.
- B. Seal vertical joints in vapor retarders over framing by lapping no fewer than two studs.
  1. Firmly attach vapor retarders to metal framing and solid substrates with vapor-retarder fasteners as recommended by vapor-retarder manufacturer.
- C. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarders.
- D. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarders.

### 3.7 PROTECTION

- A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

**END OF SECTION 07 21 00**

## SECTION 07 27 26

### FLUID-APPLIED MEMBRANE AIR BARRIERS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section includes fluid-applied, vapor-retarding membrane air barriers.
- B. Related Requirements:
  - 1. Section 06 16 00 "Sheathing" for wall sheathings and wall sheathing joint-and-penetration treatments.

##### 1.3 DEFINITIONS

- A. Air-Barrier Material: A primary element that provides a continuous barrier to the movement of air.
- B. Air-Barrier Accessory: A transitional component of the air barrier that provides continuity.
- C. Air-Barrier Assembly: The collection of air-barrier materials and accessory materials applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

##### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.
  - 2. Review air-barrier requirements and installation, special details, mockups, air-leakage and bond testing, air-barrier protection, and work scheduling that covers air barriers.

##### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Include manufacturer's written instructions for evaluating, preparing, and treating substrate; technical data; and tested physical and performance properties of products.
2. For air-barrier products, include a statement of VOC content in g/L.

B. Shop Drawings: For air-barrier assemblies.

1. Show locations and extent of air barrier. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
2. Include details of interfaces with other materials that form part of air barrier.

## 1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: From air-barrier manufacturer, certifying compatibility of air barriers and accessory materials with Project materials that connect to or that come in contact with the barrier.

C. Product Test Reports: For each air-barrier assembly, for tests performed by a qualified testing agency.

## 1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Mockups: Build mockups to set quality standards for materials and execution and for preconstruction testing.

1. Build integrated mockups of exterior wall assembly as shown on Drawings, incorporating backup wall construction, external cladding, window, storefront, door frame and sill, insulation, ties and other penetrations, and flashing to demonstrate surface preparation, crack and joint treatment, application of air barriers, and sealing of gaps, terminations, and penetrations of air-barrier assembly.
  - a. Coordinate construction of mockups to permit inspection by Owner's testing agency of air barrier before external insulation and cladding are installed.
  - b. Include junction with roofing membrane, building corner condition, and foundation wall intersection.
  - c. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air barrier until mockups are approved.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

## 1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Owner will engage a qualified testing agency to perform preconstruction testing on field mockups.

- B. Mockup Testing: Air-barrier assemblies including a window assembly shall comply with performance requirements indicated, as evidenced by reports based on mockup testing by a qualified testing agency.
  - 1. Qualitative Air-Leakage Testing: Mockups will be tested for evidence of air leakage according to ASTM E 1186, Method 4.2.6 and ASTM E 1186, Method 4.2.7.
  - 2. Quantitative Air-Leakage Testing: Mockups will be tested for air leakage according to ASTM E 783.
  - 3. Adhesion Testing: Mockups will be tested for minimum air-barrier adhesion of 30 lbf/sq. in. according to ASTM D 4541.
  - 4. Notify Architect seven days in advance of the dates and times when mockups will be tested.

#### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- B. Protect stored materials from direct sunlight.

#### 1.10 FIELD CONDITIONS

- A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended by air-barrier manufacturer.
  - 1. Protect substrates from environmental conditions that affect air-barrier performance.
  - 2. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

### **PART 2 - PRODUCTS**

#### 2.1 MATERIALS, GENERAL

- A. Source Limitations: Obtain primary air-barrier materials and air-barrier accessories from single source from single manufacturer.
- B. VOC Content: Air barrier materials shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), and complying with VOC content limits of authorities having jurisdiction.

#### 2.2 PERFORMANCE REQUIREMENTS

- A. General: Air barrier shall be capable of performing as a continuous vapor-retarding air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.
- B. Air-Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft. (0.2 L/s x sq. m of surface area at 75 Pa), when tested according to ASTM E 283 or ASTM E 783.



## 2.3 VAPOR-RETARDING MEMBRANE AIR BARRIER

- A. Fluid-Applied, Vapor-Retarding Membrane Air Barrier: elastomeric, modified bituminous membrane or synthetic polymer membrane.
1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by the Professional:
    - a. Elastomeric, Modified Bituminous Membrane:
      - 1) Carlisle Coatings & Waterproofing Inc.; Barriseal.
      - 2) Henry Company, Sealants Division; Air-Bloc 06 QS or Air-Bloc 06 WB.
      - 3) Hohmann & Barnard, Inc.; Textroflash Liquid.
      - 4) Meadows, W. R., Inc.; Air-Shield LM.
      - 5) Tremco Incorporated; ExoAir 120SP/R.
    - b. Synthetic Polymer Membrane:
      - 1) Grace, W. R., & Co. - Conn.; Perm-A-Barrier Liquid.
      - 2) Henry Company, Sealants Division; Air-Bloc 32MR.
      - 3) Rubber Polymer Corporation, Inc.; Rub-R-Wall Airtight.
  2. Physical and Performance Properties:
    - a. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. (0.02 L/s x sq. m of surface area at 75-Pa) pressure difference; ASTM E 2178.
    - b. Vapor Permeance: Maximum 0.1 perm; ASTM E 96/E 96M.
    - c. Ultimate Elongation: Minimum 500 percent; ASTM D 412, Die C.

## 2.4 ACCESSORY MATERIALS

- A. General: Accessory materials recommended by air-barrier manufacturer to produce a complete air-barrier assembly and compatible with primary air-barrier material.
- B. Primer: Low VOC liquid primer recommended for substrate by air-barrier material manufacturer.
- C. Counterflashing Strip: Modified bituminous, 40-mil- thick, self-adhering sheet consisting of 32 mils of rubberized asphalt laminated to an 8-mil- thick, cross-laminated polyethylene film with release liner backing.
- D. Modified Bituminous Strip: Vapor retarding, 40 mils thick, smooth surfaced, self-adhering; consisting of 36 mils of rubberized asphalt laminated to a 4-mil- thick polyethylene film with release liner backing.
- E. Joint Reinforcing Strip: Air-barrier manufacturer's glass-fiber-mesh tape.
- F. Substrate-Patching Membrane: Manufacturer's standard trowel-grade substrate filler.
- G. Adhesive and Tape: Air-barrier manufacturer's standard adhesive and pressure-sensitive adhesive tape.
- H. Sprayed Polyurethane Foam Sealant: One- or two-component, foamed-in-place, polyurethane foam sealant, 1.5- to 2.0-lb/cu. ft density; flame-spread index of 25 or less according to

ASTM E 162; with primer and noncorrosive substrate cleaner recommended by foam sealant manufacturer.

- I. Modified Bituminous Transition Strip: Vapor retarding, 40 mils thick, smooth surfaced, self-adhering; consisting of 36 mils of rubberized asphalt laminated to a 4-mil- thick polyethylene film with release liner backing.
- J. Adhesive-Coated Transition Strip: Vapor-permeable, 17-mil- thick, self-adhering strip consisting of an adhesive coating over a permeable laminate with a permeance value of 37 perms.
- K. Joint Sealant: ASTM C 920, single-component, neutral-curing silicone; Class 100/50 (low modulus), Grade NS, Use NT related to exposure, and, as applicable to joint substrates indicated, Use O. Comply with Section 07 92 00 "Joint Sealants."
- L. Termination Mastic: Air-barrier manufacturer's standard cold fluid-applied elastomeric liquid; trowel grade.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
  - 1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
  - 2. Verify that concrete has cured and aged for minimum time period recommended by air-barrier manufacturer.
  - 3. Verify that concrete is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
  - 4. Verify that masonry joints are flush and completely filled with mortar.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 SURFACE PREPARATION**

- A. Clean, prepare, treat, and seal substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air-barrier application.
- B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.
- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
- D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.
- E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.
- F. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.

- G. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

### 3.3 JOINT TREATMENT

- A. Concrete and Masonry: Prepare, treat, rout, and fill joints and cracks in substrate according to ASTM C 1193 and air-barrier manufacturer's written instructions. Remove dust and dirt from joints and cracks complying with ASTM D 4258 before coating surfaces.
  - 1. Prime substrate and apply a single thickness of air-barrier manufacturer's recommended preparation coat extending a minimum of 3 inches along each side of joints and cracks. Apply a double thickness of fluid air-barrier material and embed a joint reinforcing strip in preparation coat.
- B. Gypsum Sheathing: Fill joints greater than 1/4 inch with sealant according to ASTM C 1193 and air-barrier manufacturer's written instructions. Apply first layer of fluid air-barrier material at joints. Tape joints with joint reinforcing strip after first layer is dry. Apply a second layer of fluid air-barrier material over joint reinforcing strip.

### 3.4 TRANSITION STRIP INSTALLATION

- A. General: Install strips, transition strips, and accessory materials according to air-barrier manufacturer's written instructions to form a seal with adjacent construction and maintain a continuous air barrier.
  - 1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
  - 2. Install modified bituminous strip on roofing membrane or base flashing so that a minimum of 3 inches of coverage is achieved over each substrate.
- B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by fluid air-barrier material on same day. Reprime areas exposed for more than 24 hours.
  - 1. Prime glass-fiber-surfaced gypsum sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.
- C. Connect and seal exterior wall air-barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
- D. At end of each working day, seal top edge of air barrier to substrate with termination mastic.
- E. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- F. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply modified bituminous transition strip so that a minimum of 3 inches of coverage is achieved over each substrate. Maintain 3 inches of full contact over firm bearing to perimeter frames with not less than 1 inch of full contact.

- G. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air-barrier material with foam sealant.
- H. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.
- I. Seal top of through-wall flashings to air barrier with an additional 6-inch- wide, counterflashing strip.
- J. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.
- K. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches beyond repaired areas in strip direction.

### 3.5 FLUID AIR-BARRIER MEMBRANE INSTALLATION

- A. General: Apply fluid air-barrier material to form a seal with strips and transition strips and to achieve a continuous air barrier according to air-barrier manufacturer's written instructions. Apply fluid air-barrier material within manufacturer's recommended application temperature ranges.
  - 1. Apply primer to substrates at required rate and allow it to dry.
  - 2. Limit priming to areas that will be covered by fluid air-barrier material on same day. Reprime areas exposed for more than 24 hours.
  - 3. Prime glass-fiber-surfaced gypsum sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.
- B. Membrane Air Barriers: Apply a continuous unbroken air-barrier membrane to substrates according to the following thickness. Apply air-barrier membrane in full contact around protrusions such as masonry ties.
  - 1. Vapor-Retarding Membrane Air Barrier: Total 60-mil dry film thickness, applied in one or more equal coats.
- C. Do not cover air barrier until it has been tested and inspected by Owner's testing agency.
- D. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

### 3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:
  - 1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
  - 2. Continuous structural support of air-barrier system has been provided.
  - 3. Masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions, and mortar droppings.

4. Site conditions for application temperature and dryness of substrates have been maintained.
  5. Maximum exposure time of materials to UV deterioration has not been exceeded.
  6. Surfaces have been primed, if applicable.
  7. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
  8. Termination mastic has been applied on cut edges.
  9. Strips and transition strips have been firmly adhered to substrate.
  10. Compatible materials have been used.
  11. Transitions at changes in direction and structural support at gaps have been provided.
  12. Connections between assemblies (air-barrier and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
  13. All penetrations have been sealed.
- C. Owner reserves the right to have air barriers tested as recommended by Owner's testing and inspection agency, including qualitative air-leakage testing per ASTM E 1186, Methods 4.2.6 and 4.2.7, quantitative air-leakage testing per ASTM E 783, and adhesion testing per ASTM D 4541, if inspection agency reports any deficiencies of the materials and installation.
- D. Air barriers will be considered defective if they do not pass tests and inspections.
1. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
  2. Remove and replace deficient air-barrier components for retesting as specified above.
- E. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

### 3.7 CLEANING AND PROTECTION

- A. Protect air-barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.
1. Protect air barrier from exposure to UV light and harmful weather exposure as required by manufacturer. If exposed to these conditions for more than 30 days, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed membrane according to air-barrier manufacturer's written instructions.
  2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.
- B. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended by manufacturer of affected construction.
- C. Remove masking materials after installation.

**END OF SECTION 07 27 26**

## SECTION 07 42 13.23

### METAL COMPOSITE MATERIAL WALL PANELS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.2 SUMMARY

- A. Section includes metal composite material wall panels.

##### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.
  - 2. Review methods and procedures related to metal composite material panel installation, including manufacturer's written instructions.
  - 3. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
  - 4. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that affect metal composite material panels.
  - 5. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
  - 6. Review temporary protection requirements for metal composite material panel assembly during and after installation.
  - 7. Review procedures for repair of panels damaged after installation.
  - 8. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include fabrication and installation layouts of metal composite material panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment assembly, trim, flashings, closures, and accessories; and special details.
- C. Samples: For each type of metal composite material panel indicated.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

1. Metal Composite Material Panels: 12 inches long by actual panel width. Include fasteners, closures, and other metal composite material panel accessories.
- E. Delegated-Design Submittal: For metal composite material wall panel assembly indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer licensed in the **Commonwealth of Pennsylvania** responsible for their preparation.
- 1.5 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For Installer and professional engineer.
  - B. Product Test Reports: For each product, tests performed by a qualified testing agency.
  - C. Sample Warranties: For special warranties.
- 1.6 CLOSEOUT SUBMITTALS
- A. Maintenance Data: For metal composite material panels to include in maintenance manuals.
- 1.7 QUALITY ASSURANCE
- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
  - B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
    1. Build mockup of typical metal composite material panel assembly as shown on Drawings, including corner, soffits, supports, attachments, and accessories.
    2. Water-Spray Test: Conduct water-spray test of mockup of metal composite material panel assembly, testing for water penetration according to AAMA 501.2.
    3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
- 1.8 DELIVERY, STORAGE, AND HANDLING
- A. Deliver components, metal composite material panels, and other manufactured items so as not to be damaged or deformed. Package metal composite material panels for protection during transportation and handling.
  - B. Unload, store, and erect metal composite material panels in a manner to prevent bending, warping, twisting, and surface damage.
  - C. Stack metal composite material panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal composite material panels to ensure dryness, with positive slope for drainage of water. Do not store metal composite material panels in contact with other materials that might cause staining, denting, or other surface damage.
  - D. Retain strippable protective covering on metal composite material panels during installation.

## 1.9 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal composite material panels to be performed according to manufacturers' written instructions and warranty requirements.

## 1.10 COORDINATION

- A. Coordinate metal composite material panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

## 1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal composite material panel systems that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including rupturing, cracking, or puncturing.
    - b. Deterioration of metals and other materials beyond normal weathering.
  - 2. Warranty Period: Two (2) years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal composite material panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Finish Warranty Period: **Twenty (20)** years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide metal composite material panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 330:
  - 1. Wind Loads: As indicated on Drawings.
  - 2. Other Design Loads: **As indicated on Drawings.**
  - 3. Deflection Limits: For wind loads, no greater than L/60 of the span.
- B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E 283 at the following test-pressure difference:
  - 1. Test-Pressure Difference: 6.24 lbf/sq. ft.



- C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:
  - 1. Test-Pressure Difference: 6.24 lbf/sq. ft.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
  - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

## 2.2 METAL COMPOSITE MATERIAL WALL PANELS

- A. Metal Composite Material Wall Panel Systems: Provide factory-formed and -assembled, metal composite material wall panels fabricated from two metal facings that are bonded to a solid, extruded thermoplastic core; formed into profile for installation method indicated. Include attachment assembly components, panel stiffeners, and accessories required for weathertight system.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Alucobond; Plus or comparable product by one of the following, or equal approved by Professional:
    - a. 3A Composites USA, Inc.
    - b. Alcoa Inc.
    - c. CENTRIA Architectural Systems.
    - d. Citadel Architectural Products, Inc.
    - e. Firestone Metal Products, LLC.
- B. Aluminum-Faced Composite Wall Panels: Formed with 0.020-inch-thick, coil-coated aluminum sheet facings.
  - 1. Panel Thickness: 4 mm, nominal.
  - 2. Core: Standard.
  - 3. Exterior Finish: Two-coat fluoropolymer.
    - a. Color: As selected by Architect from manufacturer's full range.
- C. Attachment Assembly Components: Formed from extruded aluminum.
- D. Attachment Assembly: Rainscreen principle system.

## 2.3 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C 645, cold-formed, metallic-coated steel sheet ASTM A 653/A 653M, G90 coating designation or ASTM A 792/A 792M, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal composite material panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets,

fillers, closure strips, and similar items. Match material and finish of metal composite material panels unless otherwise indicated.

- C. Flashing and Trim: Provide flashing and trim formed from same material as metal composite material panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal composite material panels.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide 3A Composites USA Inc.; ALUCOBOND Axcnt Trim or comparable product by one of the following, or equal approved by Professional:
    - a. Arconic Architectural Products (USA).
    - b. Mitsubishi Chemical Composites.
  - 2. Aluminum Trim: Formed with 0.040-inch (1.00-mm-) thick, coil-coated aluminum sheet facings.
  - 3. Color: As selected by Architect from manufacturer's full range.
  - 4.
- D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal composite material panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.
- E. Panel Sealants: ASTM C 920; as recommended in writing by metal composite material panel manufacturer. Provide sealant types that are compatible with panel materials, are nonstaining, and do not damage panel finish.

## 2.4 FABRICATION

- A. General: Fabricate and finish metal composite material panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
  - 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
  - 2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
  - 3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
  - 4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
  - 5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
    - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

## 2.5 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Aluminum Panels and Accessories:
  - 1. Two-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal composite material panel supports, and other conditions affecting performance of the Work.
  - 1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal composite material wall panel manufacturer.
  - 2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal composite material wall panel manufacturer.
    - a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Examine roughing-in for components and assemblies penetrating metal composite material panels to verify actual locations of penetrations relative to seam locations of metal composite material panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal composite material panel manufacturer's written recommendations.

### 3.3 METAL COMPOSITE MATERIAL PANEL INSTALLATION

- A. General: Install metal composite material panels according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels

perpendicular to supports unless otherwise indicated. Anchor metal composite material panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal composite material panels.
  2. Flash and seal metal composite material panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal composite material panels are installed.
  3. Install screw fasteners in predrilled holes.
  4. Locate and space fastenings in uniform vertical and horizontal alignment.
  5. Install flashing and trim as metal composite material panel work proceeds.
  6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
  7. Align bottoms of metal composite material panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
  8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
- B. Fasteners: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
- C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal composite material panel manufacturer.
- D. Attachment Assembly, General: Install attachment assembly required to support metal composite material wall panels and to provide a complete weathertight wall system, including subgirts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels.
1. Include attachment to supports, panel-to-panel joinery, panel-to-dissimilar-material joinery, and panel-system joint seals.
- E. Installation: Attach metal composite material wall panels to supports at locations, spacings, and with fasteners recommended by manufacturer to achieve performance requirements specified.
1. Wet Seal Systems: Seal horizontal and vertical joints between adjacent metal composite material wall panels with sealant backing and sealant. Install sealant backing and sealant according to requirements specified in Section 07 92 00 "Joint Sealants."
  2. Dry Seal Systems: Seal horizontal and vertical joints between adjacent metal composite material wall panels with manufacturer's standard gasket system.
  3. Rainscreen Systems: Do not apply sealants to joints unless otherwise indicated.
- F. Rainscreen-Principle Installation: Install using manufacturer's standard assembly with vertical channel that provides support and secondary drainage assembly, draining at base of wall. Notch vertical channel to receive support pins. Install vertical channels supported by channel brackets or adjuster angles and at locations, spacings, and with fasteners recommended by manufacturer. Attach metal composite material wall panels by inserting horizontal support pins into notches in vertical channels and into flanges of panels. Leave horizontal and vertical joints with open reveal.
1. Install wall panels to allow individual panels to be installed and removed without disturbing adjacent panels.
  2. Do not apply sealants to joints unless otherwise indicated.

- G. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
1. Install components required for a complete metal composite material panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal composite material panel manufacturer; or, if not indicated, provide types recommended in writing by metal composite material panel manufacturer.
- H. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.
1. Install exposed flashing and trim that is without buckling and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof performance.
  2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

### 3.4 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align metal composite material wall panel units within installed tolerance of 1/4 inch in 20 feet, non-accumulative, on level, plumb, and location lines as indicated, and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing agency to perform field tests and inspections.
- B. Water-Spray Test: After installation, test area of assembly as directed by Architect water penetration according to AAMA 501.2.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed metal composite material wall panel installation, including accessories.
- D. Metal composite material wall panels will be considered defective if they do not pass tests and inspections.
- E. Remove and replace metal composite material wall panels where tests and inspections indicate that they do not comply with specified requirements.
- F. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.
- G. Prepare test and inspection reports.

### 3.6 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal composite material panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal composite material panel installation, clean finished surfaces as recommended by metal composite material panel manufacturer. Maintain in a clean condition during construction.
- B. After metal composite material panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace metal composite material panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

**END OF SECTION 07 42 13.23**

**SECTION 07 46 46**  
**FIBER-CEMENT SIDING**

**PART 1 - GENERAL**

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

- A. Section includes fiber-cement siding.
- B. Related Requirements:
  - 1. Section 05 40 00 - Cold-Formed Metal Framing.
  - 2. Section 06 10 53 "Miscellaneous Rough Carpentry" for wood furring, grounds, nailers, and blocking.
  - 3. Section 07 25 00 "Weather Barriers" for building wrap.

1.3 COORDINATION

- A. Coordinate siding installation with flashings and other adjoining construction to ensure proper sequencing.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Samples: For fiber-cement siding and soffit including related accessories.
- C. Samples for Verification: For each type, color, texture, and pattern required.
  - 1. 12-inch- long-by-actual-width Sample of siding.

1.6 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of fiber-cement siding.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fiber-cement siding.
- C. Research/Evaluation Reports: For each type of fiber-cement siding required, from ICC-ES.
- D. Sample Warranty: For special warranty.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of product, including related accessories, to include in maintenance manuals.

#### 1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Furnish full lengths of fiber-cement siding and soffit including related accessories, in a quantity equal to 2 percent of amount installed.

#### 1.9 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for fabrication and installation.
  - 1. Build mockup of typical wall area as shown on Drawings.
  - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

#### 1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with labels intact until time of use.
- B. Store materials on elevated platforms, under cover, and in a dry location.

#### 1.11 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace products that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including cracking and deforming.
    - b. Deterioration of materials beyond normal weathering.
  - 2. Warranty Period: Twenty-five (25) years from date of Substantial Completion.



## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Source Limitations: Obtain products, including related accessories, from single source from single manufacturer.

### **2.2 FIBER-CEMENT SIDING**

- A. General: ASTM C 1186, Type A, Grade II, fiber-cement board, noncombustible when tested according to ASTM E 136; with a flame-spread index of 25 or less when tested according to ASTM E 84.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide **EQUITONE; Tectiva Line** or comparable product by one of the following, or equal approved by Professional:
    - a. James Hardie Building Products, Inc.
    - b. James Hardie Siding Products.
    - c. Nichiha Fiber Cement.
- B. Labeling: Provide fiber-cement siding that is tested and labeled according to ASTM C 1186 by a qualified testing agency acceptable to authorities having jurisdiction.
- C. Nominal Thickness: Not less than 5/16 inch.
- D. Pattern: As indicated on Drawings.
  - 1. Texture: Smooth.
  - 2. Colors:
    - a. A: TE90 (Cream)
    - b. B: TE40 (Terra-cotta)
    - c. C: TE85 (Dark Grey)
    - d. Accent Colors: TE00, TE10 and TE60 (Warm greys, light to dark)

### **2.1 MISCELLANEOUS CLADDING MATERIALS**

- A. Perforated Insect/Vermin Screen: Manufacturer's standard.
- B. Aluminum Joint Closures and Decorative Corner Profiles: Manufacturer's standard products as detailed. Maximum thickness of non-structural finishing profile to be 0.8 mm or 21 gauge.
- C. Panel Fastening Options: Tergo+ Mechanical Secret Fixing
- E. Siding Accessories, General: Provide edge trim and other items as recommended by siding manufacturer for building configuration.
  - 1. Provide accessories matching color and texture of adjacent siding unless otherwise indicated.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

### 3.2 PREPARATION

- A. Clean panel surfaces thoroughly prior to installation. Remove any cutting or drilling dust from the surface of the panel using a micro-soft cloth. {This is especially important when panels are being adhesively fixed}
- B. Prepare surfaces using the methods recommended by Equitone for achieving the best result for the substrate under the project conditions.

### 3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved submittals.
- B. For exterior applications, comply with local codes and structural engineer's fastening calculations along with manufacturer's recommendations for fastener spacing.

### 3.4 EXTERIOR CLADDING FOR RAINSCREEN APPLICATIONS

- A. Detailing Requirements:
  - 1. Air space inlets and outlets are required at top and bottom of building or wall termination and shall be equivalent to a continuous 1/2" to 3/4" (12 mm to 18 mm) to facilitate airflow behind the panels. Do not block vertical airflow at windows, doors, eaves, or at the base of the building. Airflow shall be continuous from bottom to top so there is air movement behind each panel. The minimum cavity width should be at least 25/32" (20mm) for facades up to 33' (10m) high. For facades between 66'-165' (20-50 m) the cavity width needs to increase to 1 3/16" (30mm). Air flow behind the fiber cement panels is critical to the performance of the rain screen constructions.
  - 2. Fasteners in profile shall accommodate thermal expansion/contraction of metal and not interfere with panel application.
  - 3. Install panels starting from top of building and work down the facade.
  - 4. For straight walls, start panel installation in center and work outward.
  - 5. For walls with inside corners, start installation at corner and work across wall.
  - 6. Pattern: Straight pattern with vertical panels. Panel size as indicated.
  - 7. Pattern: Straight pattern with horizontal panels. Panel size as indicated.
  - 8. Pattern: Semi pattern with horizontal panels. Panel size as indicated.
- B. Rain Screen Installation: Comply with manufacturer's installation requirements.

### 3.5 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

**END OF SECTION 07 46 46**

## SECTION 07 54 23

### THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:

- 1. Adhered thermoplastic polyolefin (TPO) roofing system.
- 2. Vapor retarder.
- 3. Roof insulation.

- B. Related Requirements:

- 1. Section 06 10 53 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking; and for wood-based, structural-use roof deck panels.
- 2. Section 06 16 00 "Sheathing" for wood-based, structural-use roof deck panels.
- 3. Section 07 21 00 "Thermal Insulation" for insulation beneath the roof deck.
- 4. Section 07 62 00 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
- 5. Section 07 71 29 "Manufactured Roof Expansion Joints" for proprietary manufactured roof expansion-joint assemblies.
- 6. Section 07 72 00 "Roof Accessories" for roof hatches.
- 7. Section 07 92 00 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

##### 1.3 DEFINITIONS

- A. Roofing Terminology: Definitions in ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" apply to work of this Section.

##### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Roofing Conference: Conduct conference at Project site.

- 1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.
- 2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.

3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work, including:
  1. Base flashings and membrane terminations.
  2. Tapered insulation, including slopes.
  3. Roof plan showing orientation of steel roof deck and orientation of roofing, fastening spacings, and patterns for mechanically fastened roofing.
  4. Crickets and saddles, including width, length, and slopes.
  5. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
- C. Draft copy of the roofing warranty be included with the roof system submittal.
- D. Samples for Verification: For the following products:
  1. Sheet roofing, of color required.
  2. Walkway pads or rolls, of color required.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturer.
- B. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
  1. Submit evidence of compliance with performance requirements.
- C. Pre-Installation Notice: Roof Installer to provide Pre-Installation Notice (PIN) indicating that this Project has been reviewed by the roofing manufacturer for warranty eligibility upon successful completion.
- D. Product Test Reports: For components of roofing system, tests performed by manufacturer and witnessed by a qualified testing agency.
- E. Research/Evaluation Reports: For components of roofing system, from ICC-ES.
- F. Field quality-control reports.

- G. Sample Warranties: For manufacturer's special warranties.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roofing system to include in maintenance manuals.

#### 1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is UL listed for roofing system identical to that used for this Project.
- B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

#### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
  - 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.
- E. Insulation and weather-sensitive materials stocked on the roof shall be elevated or stored on pallets and covered with tarps.

#### 1.10 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

#### 1.11 ROOFING WARRANTY

- A. Quality Assurance:
  - 1. Manufacturer Qualifications: The manufacturer shall have a minimum of ten (10) years' experience in the production of the type of roofing herein specified, and shall be able to show experience with projects of similar size and complexity.

2. The Installer Qualifications: The installer shall have a minimum of five (5) years' experience installing the type of roofing herein specified, on projects of similar size and complexity.

B. Contractor's Warranty:

1. Contractor's Responsibility: The General Contractor shall take, or cause to have taken, any and all corrective measures necessary to keep the roofing system free of all defects, to the satisfaction of the Department, and to maintain the roofing system in a watertight condition. The Contractor shall have the responsibility for said corrective measures for two (2) years after the date of Final Inspection. The Contractor shall be responsible for the removal and replacement of the roofing system, if in the judgment of the Department, removal and replacement is necessary to keep the roofing system free of all defects or to maintain the roofing system in a watertight condition. The Contractor shall also repair, or remove and replace, if the Department deems it to be necessary, any part of the building, including the interior, damaged as a result of leaks in the roofing system. The interior of the building includes, but is not limited to, the furnishings and fixtures. There shall be no limit to the Contractor's liability for fulfilling the aforementioned responsibilities.
  - a. Final Inspection shall include a statement, supplied by the Contractor and signed by an authorized representative of the roofing manufacturer, attesting to the fact that the roofing installation and finished condition is acceptable for warranty by that manufacturer.
2. Exclusions: The Contractor shall not be responsible for repairs to, or replacement of, the roofing system, if repairs or replacement is necessary due to a natural disaster, such as lightning, hail, flood, tornado or earthquake.
3. Notification: The Department will notify the Contractor, as soon as reasonably possible, after it has knowledge of defects in the roofing system. Should the Contractor fail to promptly take corrective measures, the Department may undertake corrective measures. The Contractor shall be responsible for any and all expenses incurred by the Department in undertaking the necessary corrective measures. In addition, the Department's undertaking of corrective measures shall in no way relieve the Contractor of any of the aforementioned responsibilities.

C. Manufacturer's Warranty:

1. The General Contractor shall provide the Department with a twenty (20) year warranty, furnished by the manufacturer, which shall warrant that the said manufacturer will repair any leaks in the roofing system, not to exceed the original cost of the installed roof over the life of the warranty, installed by an applicator authorized by said manufacturer.
2. Leaks from the following causes shall be covered by the manufacturer's warranty:
  - a. Defects in the roofing system material.
  - b. Workmanship of the authorized applicator.
3. The following exclusions are permitted in the manufacturer's warranty:
  - a. Natural disasters such as lightning, hail, floods, tornadoes or earthquakes.
  - b. Damage from traffic or storage of materials on the roof.
  - c. Structural failure of roof deck, parapet or coping.
  - d. Infiltration of moisture in, through or around walls, coping or building structure.
  - e. Movement or deterioration of metal counterflashing or other metal components adjacent to the roof.
  - f. Damage to the building (other than roofing and insulation) or its components adjacent to the roof.
4. The warranty shall provide that in the event a leak should occur within the warranty period, and if such leak is within the coverage of the warranty, the warrantor will, at no expense to the Department, make or have made, all necessary repairs to put the roof membrane, base flashing and roof insulation in a dry and watertight condition, using the same materials and specifications as the original application. There will be no limit to the warrantor's liability for making such repairs over the period of the warranty.

5. The warranty shall provide that if, upon proper notification, the warrantor fails to promptly repair the roof, and the Department may make temporary repairs to avoid damage to the facility. Such action shall not be considered a breach of the provisions of the warranty.
6. The Department shall be permitted to make alterations, additions and repairs to the roof, within the written approved guidelines of the warrantor without jeopardizing the unexpired portion of the warranty's original term.
7. Metal roofs and exposed fasteners shall be warranted against rust. Also, on metal roofs, the manufacturer, upon completion, inspection and written acceptance of the roof installation, shall furnish a warranty covering paint finish against cracking, checking, blistering, peeling, flaking and chipping for a period of twenty (20) years.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Firestone Building Products; UltraPly Platinum TPO or comparable product by one of the following, or equal approved by the Professional:
  1. Carlisle SynTec Incorporated.
  2. Firestone Building Products.
  3. Johns Manville.
- B. Source Limitations: Obtain components including roof insulation and fasteners for roofing system from same manufacturer as membrane roofing.

### **2.2 PERFORMANCE REQUIREMENTS**

- A. General Performance: Installed roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing and base flashings shall remain watertight.
  1. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G 151 or ASTM G 155.
  2. Impact Resistance: Roofing system shall resist impact damage when tested according to ASTM D 3746 or ASTM D 4272.
- B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.
- C. Roofing System Design: Provide a roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressures calculated according to ASCE/SEI.
- D. Energy Star Listing: Roofing system shall be listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.
- E. Exterior Fire-Test Exposure: ASTM E 108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

- F. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.

## 2.3 TPO ROOFING

- A. Fabric-Reinforced TPO Sheet: ASTM D 6878, internally fabric- or scrim-reinforced, uniform, flexible TPO sheet.
  - 1. Thickness: 60 mils, nominal.
  - 2. Exposed Face Color: Gray.
    - a. Provide TPO sheet with an SRI meeting the minimum requirement as specified in "Performance Requirements" article.

## 2.4 AUXILIARY ROOFING MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing.
  - 1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
- B. Sheet Flashing: Manufacturer's standard unreinforced TPO sheet flashing, 60 mils thick, minimum, of same color as TPO sheet.
- C. Bonding Adhesive: Manufacturer's standard, low VOC.
- D. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roofing to substrate, and acceptable to roofing system manufacturer.
- E. Miscellaneous Accessories: Provide metal termination bars, metal battens, pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

## 2.5 SUBSTRATE BOARDS

- A. Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, Type X, 5/8 inch thick.
  - 1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by the Professional:
    - a. CertainTeed Corporation; GlasRoc Sheathing.
    - b. Georgia-Pacific Corporation; Dens Deck.
    - c. National Gypsum Company; Gold Bond eXP Extended Exposure Sheathing.
    - d. USG Corporation; Securock Glass Mat Roof Board.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening substrate board to roof deck.



## 2.6 VAPOR RETARDER

- A. Self-Adhering-Sheet Vapor Retarder: ASTM D 5147, SBS-modified bitumen adhesive, factory-laminated to a tri-laminate woven, high-density polyethylene top surface; minimum 30-mil total thickness; maximum permeance rating of 0.02 perm.

## 2.7 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured by TPO roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated.
- B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 (20 psi), felt or glass-fiber mat facer on both major surfaces.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by the Professional:
    - a. Atlas Roofing Corporation.
    - b. Carlisle SynTec Incorporated.
    - c. Firestone Building Products.
    - d. GAF Materials Corporation.
    - e. Hunter Panels.
    - f. Johns Manville.
    - g. Rmax, Inc.
- C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches unless otherwise indicated.
- D. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

## 2.8 INSULATION ACCESSORIES

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with roofing.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.
- C. Insulation Adhesive: Insulation manufacturer's recommended low VOC adhesive formulated to attach roof insulation to substrate or to another insulation layer.
- D. Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/2 inch thick, factory primed.
  - 1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by the Professional:
    - a. CertainTeed Corporation; GlasRoc Sheathing.
    - b. Georgia-Pacific Corporation; Dens Deck Prime.
    - c. National Gypsum Company; Gold Bond eXP Extended Exposure Sheathing.
    - d. USG Corporation; Securock Glass Mat Roof Board.

## 2.9 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch thick and acceptable to roofing system manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work:
  - 1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
  - 2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
  - 3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 05 31 00 "Steel Decking."
  - 4. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
  - 5. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
  - 6. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

### 3.3 ROOFING INSTALLATION, GENERAL

- A. Install roofing system according to roofing system manufacturer's written instructions.
- B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
- C. Roof Installer to provide warrantable status notification signage at all points of roof access.

### 3.4 SUBSTRATE BOARD INSTALLATION

- A. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
  - 1. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to roofing system manufacturers' written instructions.

### 3.5 VAPOR-RETARDER INSTALLATION

- A. Self-Adhering-Sheet Vapor Retarder: Install membrane with minimum 3 inch side laps and 6 inch end laps. Roll membrane with a 75 lb. roller to fully mate each roll, including all lap areas. Verify with manufacturer if primer is required based upon deck composition.
- B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

### 3.6 INSULATION INSTALLATION

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Install tapered insulation under area of roofing to conform to slopes indicated.
- D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches or greater, install two or more layers with joints of each succeeding layer staggered and offset from joints of previous layer a minimum of 6 inches in each direction.
- E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
- F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.
  - 1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
- G. Mechanically Fastened Insulation with Adhered Cover Board: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
  - 1. Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.
  - 2. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered and offset between rows. Offset joints of insulation below a minimum of 6 inches in each direction. Loosely butt cover boards together.
    - a. Set cover boards in insulation adhesive, firmly pressing and maintaining insulation in place.

### 3.7 ADHERED ROOFING INSTALLATION

- A. Adhere roofing over area to receive roofing according to roofing system manufacturer's written instructions. Unroll roofing and allow to relax before retaining.
- B. Start installation of roofing in presence of roofing system manufacturer's technical personnel.
- C. Accurately align roofing, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- D. Bonding Adhesive: Apply to substrate and underside of roofing at rate required by manufacturer, and allow to partially dry before installing roofing. Do not apply to splice area of roofing.
- E. In addition to adhering, mechanically fasten roofing securely at terminations, penetrations, and perimeter of roofing.
- F. Apply roofing with side laps shingled with slope of roof deck where possible.
- G. Seams: Clean seam areas, overlap roofing, and hot-air weld side and end laps of roofing and sheet flashings according to manufacturer's written instructions, to ensure a watertight seam installation.
  - 1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet.
  - 2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
  - 3. Repair tears, voids, and lapped seams in roofing that do not comply with requirements.
- H. Spread sealant bed over deck-drain flange at roof drains, and securely seal roofing in place with clamping ring.
- I. Where rooftop equipment is to be installed on top of roofing system membrane, adhere an extra sheet of roofing membrane, walkway products, or other material as recommended by roofing manufacturer.

### 3.8 BASE FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

### 3.9 WALKWAY INSTALLATION

- A. Flexible Walkways: Install walkway products in locations indicated. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

### 3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components, and to furnish reports to Architect.
- B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
  - 1. Notify Owner and Architect at least 48 hours in advance of date and time of inspection.
- C. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

### 3.11 PROTECTING AND CLEANING

- A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

**END OF SECTION 07 54 23**

## SECTION 07 62 00

### SHEET METAL FLASHING AND TRIM

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:

1. Formed roof-drainage sheet metal fabrications.
2. Formed low-slope roof sheet metal fabrications.
3. Formed equipment support flashing.
4. Formed overhead-piping safety pans.

- B. Related Requirements:

1. Section 04 20 00 "Unit Masonry" for concealed flexible flashings installed in exterior masonry construction.
2. Section 05 50 00 "Metal Fabrications" for downspout boots.
3. Section 06 10 53 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
4. Section 07 72 00 "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
5. Section 07 95 00 "Expansion Control" for manufactured sheet metal expansion-joint covers.

##### 1.3 COORDINATION

- A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
- B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

##### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.
2. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

3. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
4. Review requirements for insurance and certificates if applicable.
5. Review sheet metal flashing observation and repair procedures after flashing installation.

## 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For sheet metal flashing and trim.
  1. Include plans, elevations, sections, and attachment details.
  2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work.
  3. Include identification of material, thickness, weight, and finish for each item and location in Project.
  4. Include details for forming, including profiles, shapes, seams, and dimensions.
  5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
  6. Include details of termination points and assemblies.
  7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
  8. Include details of roof-penetration flashing.
  9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings as applicable.
  10. Include details of special conditions.
  11. Include details of connections to adjoining work.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Samples for Verification: For each type of exposed finish.
  1. Sheet Metal Flashing: 12 inches long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
  2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches long and in required profile. Include fasteners and other exposed accessories.
  3. Unit-Type Accessories and Miscellaneous Materials: Full-size Sample.
  4. Anodized Aluminum Samples: Samples to show full range to be expected for each color required.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.
- B. Sample Warranty: For special warranty.

## 1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sheet metal flashing and trim, and its accessories, to include in maintenance manuals.

## 1.8 QUALITY ASSURANCE

- A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

## 1.10 WARRANTY

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Finish Warranty Period: Twenty (20) years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. SPRI Wind Design Standard: Manufacture and install copings tested according to SPRI ES-1 and capable of resisting the following design pressure:
  - 1. Design Pressure: As indicated on Drawings.
- D. Recycled Content of Zinc-Sheet Flashing and Trim: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 15 percent.



- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

- 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

## 2.2 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

- B. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required.

- 1. Exposed Coil-Coated Finish:

- a. Two-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

- 1) Color: As selected by Architect from manufacturer's full range.

- 2. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

- C. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, dead soft, fully annealed; 2D (dull, cold rolled).

## 2.3 UNDERLAYMENT MATERIALS

- A. Felt: ASTM D 226/D 226M, Type II (No. 30), asphalt-saturated organic felt; nonperforated.

- B. Self-Adhering, High-Temperature Sheet: Minimum 30 mils thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer according to written recommendations of underlayment manufacturer.

- 1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F or higher.
  - 2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F or lower.

- C. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. minimum.

## 2.4 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal unless otherwise indicated.

- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal.
  - 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
    - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
    - b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
    - c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
  - 2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
  - 3. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
- C. Solder:
  - 1. For Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
- D. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
- E. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- F. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- G. Bituminous Coating: Cold-applied asphalt emulsion according to ASTM D 1187.
- H. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

## 2.5 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
  - 1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
  - 2. Obtain field measurements for accurate fit before shop fabrication.
  - 3. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
  - 4. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

- B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
- C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
  - 1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
  - 2. Use lapped expansion joints only where indicated on Drawings.
- D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.
- E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.
- G. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.
- H. Do not use graphite pencils to mark metal surfaces.

## 2.6 ROOF-DRAINAGE SHEET METAL FABRICATIONS

- A. Hanging Gutters: Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 96-inch- long sections. Furnish flat-stock gutter brackets and gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard but with thickness not less than twice the gutter thickness. Fabricate expansion joints, expansion-joint covers, and gutter accessories from same metal as gutters. Shop fabricate interior and exterior corners.
  - 1. Gutter Profile: Style H according to cited sheet metal standard.
  - 2. Expansion Joints: Butt type with cover plate.
  - 3. Accessories: Continuous, removable leaf screen with sheet metal frame and hardware cloth screen.
  - 4. Gutters with Girth up to 15 Inches: Fabricate from the following materials:
    - a. Aluminum: 0.032 inch thick.
  - 5. Gutters with Girth 16 to 20 Inches: Fabricate from the following materials:
    - a. Aluminum: 0.040 inch thick.
  - 6. Gutters with Girth 21 to 25 Inches: Fabricate from the following materials:
    - a. Aluminum: 0.050 inch thick.
  - 7. Gutters with Girth 26 to 30 Inches: Fabricate from the following materials:
    - a. Aluminum: 0.063 inch thick.
- B. Downspouts: Fabricate rectangular downspouts to dimensions indicated, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors. Shop fabricate elbows.

1. Manufactured Hanger Style: Fig 1-34A according to SMACNA's "Architectural Sheet Metal Manual."
  2. Fabricate from the following materials:
    - a. Aluminum: 0.024 inch thick.
- C. Splash Pans: Fabricate to dimensions and shape required and from the following materials:
1. Zinc: 0.032 inch thick.

## 2.7 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Roof Edge Flashing (Gravel Stop) and Fascia Cap: Fabricate in minimum 96-inch- long, but not exceeding 12-foot- long sections. Furnish with 6-inch- wide, joint cover plates. Shop fabricate interior and exterior corners.
1. Joint Style: Butted with expansion space and 6-inch- wide, concealed backup plate.
  2. Fabricate from the Following Materials:
    - a. Aluminum: 0.050 inch thick.
- B. Copings: Fabricate in minimum 96-inch- long, but not exceeding 12-foot- long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and interior leg. Miter corners, fasten and seal. Shop fabricate interior and exterior corners. Fabricate from the Following Materials:
- a. Aluminum: 0.050 inch thick.
- C. Base Flashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:
1. Stainless Steel: 0.019 inch, 26-gage thick.
- D. Counterflashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:
1. .
  2. Stainless Steel: 0.019 inch, 26-gage thick.
- E. Flashing Receivers: Fabricate from the following materials:
1. Stainless Steel: 0.019 inch, 26-gage thick.
- F. Roof-Penetration Flashing: Fabricate from the following materials:
1. Stainless Steel: 0.019 inch, 26-gage thick.
- G. Roof-Drain Flashing: Fabricate from the following materials:
1. Stainless Steel: 0.019 inch, 26-gage thick.

## 2.8 MISCELLANEOUS SHEET METAL FABRICATIONS

- A. Equipment Support Flashing: Fabricate from the following materials:
1. Stainless Steel: 0.019 inch, 26-gage thick.
- B. Overhead-Piping Safety Pans: Fabricate from the following materials:
1. Stainless Steel: 0.025 inch, 24-gage thick.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.
  - 1. Verify compliance with requirements for installation tolerances of substrates.
  - 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
  - 3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 UNDERLAYMENT INSTALLATION**

- A. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches.
- B. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Prime substrate if recommended by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller. Cover underlayment within 14 days.
- C. Apply slip sheet, wrinkle free, over underlayment before installing sheet metal flashing and trim.

### **3.3 INSTALLATION, GENERAL**

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
  - 1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
  - 2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
  - 3. Space cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
  - 4. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.
  - 5. Torch cutting of sheet metal flashing and trim is not permitted.
  - 6. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or

corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

1. Coat concealed side of uncoated-aluminum and stainless-steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
  2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.
1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
  2. Use lapped expansion joints only where indicated on Drawings.
- D. Fasteners: Use fastener sizes that penetrate wood blocking or sheathing not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.
- E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
- F. Seal joints as required for watertight construction.
1. Use sealant-filled joints unless otherwise indicated. Embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F.
  2. Prepare joints and apply sealants to comply with requirements in Section 07 92 00 "Joint Sealants."
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets with solder to width of 1-1/2 inches; however, reduce pre-tinning where pre-tinned surface would show in completed Work.
1. Do not solder aluminum sheet.
  2. Do not use torches for soldering.
  3. Heat surfaces to receive solder, and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
  4. Stainless-Steel Soldering: Tin edges of uncoated sheets, using solder for stainless steel and acid flux. Promptly remove acid flux residue from metal after tinning and soldering. Comply with solder manufacturer's recommended methods for cleaning and neutralization.
- H. Rivets: Rivet joints in uncoated aluminum where necessary for strength.

### 3.4 ROOF-DRAINAGE SYSTEM INSTALLATION

- A. General: Install sheet metal roof-drainage items to produce complete roof-drainage system according to cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.

- B. Hanging Gutters: Join sections with riveted and soldered joints. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchor them in position. Provide end closures and seal watertight with sealant. Slope to downspouts.
  - 1. Install gutter with expansion joints at locations indicated, but not exceeding, 50 feet apart. Install expansion-joint caps.
- C. Downspouts: Join sections with 1-1/2-inch telescoping joints.
  - 1. Provide hangers with fasteners designed to hold downspouts securely to walls. Locate hangers at top and bottom and at approximately 60 inches o.c.
  - 2. Provide elbows at base of downspout to direct water away from building.
- D. Splash Pans: Install where downspouts discharge on low-slope roofs. Set in asphalt roofing cement or elastomeric sealant compatible with the substrate.
- E. Expansion-Joint Covers: Install expansion-joint covers at locations and of configuration indicated. Lap joints minimum of 4 inches in direction of water flow.

### 3.5 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal flashing and trim to comply with performance requirements and cited sheet metal standard. Provide concealed fasteners where possible, and set units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
- B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch centers.
- C. Copings: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated.
  - 1. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 24-inch centers.
  - 2. Anchor interior leg of coping with washers and screw fasteners through slotted holes at 24-inch centers.
- D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.
- E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints minimum of 4 inches. Secure in waterproof manner by means of anchor and washer at 36-inch centers unless otherwise indicated.
- F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

### 3.6 MISCELLANEOUS FLASHING INSTALLATION

- A. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with elastomeric sealant to equipment support member.
- B. Overhead-Piping Safety Pans: Suspend pans from structure above, independent of other overhead items such as equipment, piping, and conduit, unless otherwise indicated on Drawings. Pipe and install drain line to plumbing waste or drainage system.

### 3.7 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

### 3.8 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.
- D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended by sheet metal flashing and trim manufacturer. Maintain sheet metal flashing and trim in clean condition during construction.
- E. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

**END OF SECTION 07 62 00**



## SECTION 07 71 29

### MANUFACTURED ROOF EXPANSION JOINTS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section includes bellows-type roof expansion joints.
- B. Related Requirements:
  - 1. Section 06 10 53 "Miscellaneous Rough Carpentry" for wooden curbs or cants for mounting roof expansion joints.
  - 2. Section 07 54 23 "Thermoplastic Polyolefin (TPO) Roofing" for roofing system.
  - 3. Section 07 62 00 "Sheet Metal Flashing and Trim" for shop- and field-fabricated sheet metal expansion-joint systems, flashing, and other sheet metal items.
  - 4. Section 07 72 00 "Roof Accessories" for manufactured and prefabricated metal roof curbs.

##### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For roof expansion joints.
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Include details of splices, intersections, transitions, fittings, method of field assembly, and location and size of each field splice.
  - 3. Provide isometric drawings of intersections, terminations, and changes in joint direction or planes, depicting how components interconnect with each other and adjacent construction to allow movement and achieve waterproof continuity.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each fire-barrier provided as part of a roof-expansion-joint assembly, for tests performed by a qualified testing agency.
- C. Sample Warranties: For special warranties.

## 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Installer of roofing membrane.

## 1.7 WARRANTY

- A. Special Warranty: Manufacturer and Installer agree to repair or replace roof expansion joints and components that leak, deteriorate beyond normal weathering, or otherwise fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Two (2) years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### 2.1 PERFORMANCE REQUIREMENTS

- A. General: Roof expansion joints shall withstand exposure to weather, remain watertight, and resist the movements indicated without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint seals, failure of connections, and other detrimental effects.
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- C. Fire-Test-Response Characteristics: Provide fire-barrier assemblies with fire-test-response characteristics as determined by testing identical products, per test method indicated, by UL or another testing agency acceptable to authorities having jurisdiction. Assemblies shall be capable of anticipated movement while maintaining fire rating. Fire-barrier products shall bear classification marking of qualified testing agency.

### 2.2 BELLOWS-TYPE ROOF EXPANSION JOINTS

- A. Source Limitations: Obtain bellows-type roof expansion joints approved by roofing manufacturer and that are part of roofing membrane warranty.
- B. Flanged Bellows Roof Expansion Joint: Manufactured, continuous, waterproof, joint-cover assembly, consisting of exposed membrane bellows, laminated to flexible, closed-cell support foam, and secured along each edge to a 3- to 4-inch- wide metal flange for nailing to substrate. Provide factory-fabricated units for corner and joint intersections and horizontal and vertical transitions including those to other building expansion joints, splicing units, adhesives, and other

components as recommended by roof-expansion-joint manufacturer for complete installation. Fabricate each assembly specifically for installation configuration indicated on Drawings.

1. Basis-of-Design Product: Subject to compliance with requirements, provide C/S Group; Model BRJ or comparable product by one of the following, or equal approved by the Professional:
  - a. Architectural Art Manufacturing Inc.; a division of Pittcon Architectural Metals, LLC.
  - b. Balco, Inc.
  - c. Building Materials Corporation of America; GAF Materials Corporation.
  - d. C/S Group.
  - e. InPro Corporation.
  - f. Johns Manville; a Berkshire Hathaway company.
  - g. MM Systems Corporation.
  - h. Watson Bowman Acme Corp.
2. Joint Movement Capability: Plus and minus 50 percent of joint size.
3. Bellows: EPDM flexible membrane, nominal 60 mils thick.
  - a. Color: Black.
4. Flanges: Galvanized steel, 0.022 inch thick.
  - a. Form: As indicated on Drawings as indicated on Drawings.
5. Cover Membrane: EPDM flexible membrane, factory laminated to bellows and covering entire joint assembly and curbs.
  - a. Color: Black.
6. Fire Barrier: Manufacturer's standard fire-resistive joint system with ratings determined per ASTM E 1966 or UL 2079 to resist spread of fire and to accommodate building thermal movements without impairing its ability to resist the passage of fire and hot gases.
  - a. Fire-Resistance Rating: Not less than fire-resistance rating of the roof assembly.

## 2.3 MATERIALS

- A. Galvanized-Steel Sheet: ASTM A 653/A 653M, hot-dip zinc-coating designation G90.
- B. EPDM Membrane: ASTM D 4637, Type standard with manufacturer for application.
- C. Adhesives: Use adhesives on the interior of the building as recommended by roof-expansion-joint manufacturer and with a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to withstand design loads.
  1. Exposed Fasteners: Gasketed. Use screws with hex washer heads matching color of material being fastened.
- E. Mineral-Fiber Blanket: ASTM C 665.

- F. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Examine roof-joint openings, inside surfaces of parapets, and expansion-control joint systems that interface with roof expansion joints, for suitable conditions where roof expansion joints will be installed.
- C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 INSTALLATION**

- A. General: Comply with manufacturer's written instructions for handling and installing roof expansion joints.
  - 1. Anchor roof expansion joints securely in place, with provisions for required movement. Use fasteners, protective coatings, sealants, and miscellaneous items as required to complete roof expansion joints.
  - 2. Install roof expansion joints true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
  - 3. Provide for linear thermal expansion of roof expansion joint materials.
  - 4. Provide uniform profile of roof expansion joint throughout its length; do not stretch or squeeze membranes.
  - 5. Provide uniform, neat seams.
  - 6. Install roof expansion joints to fit substrates and to result in watertight performance.
  - 7. Torch cutting of roof expansion joints is not permitted.
- B. Directional Changes and Other Expansion-Control Joint Systems: Coordinate installation of roof expansion joints with other expansion-control joint systems to result in watertight performance. Install factory-fabricated units at directional changes and at transitions between roof expansion joints and exterior expansion-control joint systems specified in Section 07 95 00 "Expansion Control" to provide continuous, uninterrupted, and watertight joints.
- C. Splices: Splice roof expansion joints with materials provided by roof-expansion-joint manufacturer for this purpose, to provide continuous, uninterrupted, and waterproof joints.
- D. Fire Barrier: Install fire barrier where indicated to provide continuous, uninterrupted fire resistance throughout length of roof expansion joint, including transitions and end joints.
- E. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

3.3 PROTECTION

- A. Protect roof expansion joints from foot traffic, displacement, or other damage.
- B. Remove and replace roof expansion joints and components that become damaged by moisture or otherwise.

**END OF SECTION 07 71 29**

## SECTION 07 72 00

### ROOF ACCESSORIES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:

1. Roof curbs.
2. Equipment supports.
3. Roof hatches.
4. Preformed Flashing Sleeves

- B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for metal vertical ladders, ships' ladders, and stairs for access to roof hatches.
2. Section 07 62 00 "Sheet Metal Flashing and Trim" for shop- and field-formed metal flashing, roof-drainage systems, roof expansion-joint covers, and miscellaneous sheet metal trim and accessories.
3. Section 07 71 29 "Manufactured Roof Expansion Joints" for manufactured roof expansion-joint covers.

##### 1.3 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of roof accessory indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Samples: For each exposed product and for each color and texture specified.

##### 1.5 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

## 1.7 COORDINATION

- A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.
- B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

## 1.8 WARRANTY

- A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Finish Warranty Period: Twenty (20) years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 METAL MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation.
  - 1. Exposed Coil-Coated Finish: Two-coat fluoropolymer finish; AAMA 621; system consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
  - 2. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat.
- B. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, AZ50 coated.
  - 1. Exposed Coil-Coated Finish: Two-coat fluoropolymer finish; AAMA 621; system consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
  - 2. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat.
- C. Aluminum Sheet: ASTM B 209, manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.
  - 1. Clear Anodic Finish: AAMA 611, Class II, 0.010 mm or thicker.

2. Exposed Coil-Coated Finish: Two-coat fluoropolymer finish; AAMA 620; system consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
  3. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils.
- D. Aluminum Extrusions and Tubes: ASTM B 221, manufacturer's standard alloy and temper for type of use, finished to match assembly where used, otherwise mill finished.
  - E. Stainless-Steel Sheet and Shapes: ASTM A 240/A 240M or ASTM A 666, Type 304.
  - F. Steel Shapes: ASTM A 36/A 36M, hot-dip galvanized according to ASTM A 123/A 123M unless otherwise indicated.
  - G. Steel Tube: ASTM A 500, round tube.
  - H. Galvanized-Steel Tube: ASTM A 500, round tube, hot-dip galvanized according to ASTM A 123/A 123M.
  - I. Steel Pipe: ASTM A 53/A 53M, galvanized.

## 2.2 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. Glass-Fiber Board Insulation: ASTM C 726, thickness as indicated.
- C. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches thick.
- D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.
- E. Underlayment:
  1. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
  2. Polyethylene Sheet: 6-mil- thick polyethylene sheet complying with ASTM D 4397.
  3. Slip Sheet: Building paper, 3-lb/100 sq. ft. minimum, rosin sized.
- F. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
  1. Fasteners for Zinc-Coated or Aluminum-Zinc Alloy-Coated Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A 153/A 153M or ASTM F 2329.
  2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
- G. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.
- H. Sealants: As recommended by roof accessory manufacturer for installation indicated.



- I. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

## 2.3 ROOF CURBS

- A. Roof Curbs: Internally reinforced roof-curb units with integral spring-type vibration isolators and capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings; with welded or mechanically fastened and sealed corner joints, stepped integral metal cant raised the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by the Professional:
    - a. AES Industries, Inc.
    - b. Curbs Plus, Inc.
    - c. Custom Solution Roof and Metal Products.
    - d. Greenheck Fan Corporation.
    - e. LM Curbs.
    - f. Metallic Products Corp.
    - g. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
    - h. Pate Company (The).
    - i. Roof Products, Inc.
    - j. Safe Air of Illinois.
    - k. Thybar Corporation.
    - l. Vent Products Co., Inc.
- B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- C. Loads: As indicated on Drawings.
- D. Material: Zinc-coated (galvanized) steel sheet, 0.052 inch, 18-gage thick.
  - 1. Finish: Baked enamel or powder coat .
  - 2. Color: As selected by Architect from manufacturer's full range.
- E. Construction:
  - 1. Insulation: Factory insulated with 1-1/2-inch-thick glass-fiber board insulation.
  - 2. Liner: Same material as curb, of manufacturer's standard thickness and finish.
  - 3. Factory-installed wood nailer at top of curb, continuous around curb perimeter.
  - 4. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
  - 5. Fabricate curbs to minimum height of 12 inches unless otherwise indicated.
  - 6. Top Surface: Level around perimeter with roof slope accommodated by sloping the deck-mounting flange.
  - 7. Sloping Roofs: Where roof slope exceeds 1:48, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.

## 2.4 EQUIPMENT SUPPORTS

- A. Equipment Supports: Internally reinforced metal equipment supports capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings; with welded or mechanically fastened and sealed corner joints, stepped integral metal cant raised the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by Professional:
    - a. AES Industries, Inc.
    - b. Curbs Plus, Inc.
    - c. Custom Solution Roof and Metal Products.
    - d. Greenheck Fan Corporation.
    - e. LM Curbs.
    - f. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
    - g. Pate Company (The).
    - h. Roof Products, Inc.
    - i. Thybar Corporation.
    - j. Vent Products Co., Inc.
- B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- C. Loads: As indicated on Drawings.
- D. Material: Zinc-coated (galvanized) steel sheet, 0.052 inch, 18-gage thick.
1. Finish: Baked enamel or powder coat.
  2. Color: As selected by Architect from manufacturer's full range.
- E. Construction:
1. Insulation: Factory insulated with 1-1/2-inch-thick glass-fiber board insulation.
  2. Liner: Same material as equipment support, of manufacturer's standard thickness and finish.
  3. Factory-installed continuous wood nailers 5-1/2 inches wide at tops of equipment supports.
  4. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as equipment support.
  5. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
  6. Fabricate equipment supports to minimum height of 12 inches unless otherwise indicated.
  7. Sloping Roofs: Where roof slope exceeds 1:48, fabricate each support with height to accommodate roof slope so that tops of supports are level with each other. Equip supports with water diverters or crickets on sides that obstruct water flow.

## 2.5 ROOF HATCH

- A. Roof Hatches: Metal roof-hatch units with lids and insulated double-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and

weathertight perimeter gasketing, stepped integral metal cant raised the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by Professional:
  - a. Babcock-Davis.
  - b. Bilco Company (The).
  - c. J. L. Industries, Inc.
  - d. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
  - e. Nystrom.
  
- B. Type and Size: Single-leaf lid, 30 by 54 inches.
  
- C. Loads: Minimum 40-lbf/sq. ft. external live load and 20-lbf/sq. ft. internal uplift load.
  
- D. Hatch Material: Zinc-coated (galvanized) steel sheet, 0.079 inch, 14-gage thick.
  1. Finish: Baked enamel or powder coat.
  2. Color: As selected by Architect from manufacturer's full range.
  
- E. Construction:
  1. Insulation: Glass-fiber board.
  2. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
  3. Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
  4. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
  5. Fabricate curbs to minimum height of 12 inches unless otherwise indicated.
  6. Sloping Roofs: Where slope or roof deck exceeds 1:48, fabricate curb with perimeter curb height that is constant. Equip hatch with water diverter or cricket on side that obstructs water flow.
  
- F. Hardware: Galvanized-steel spring latch with turn handles, butt- or pintle-type hinge system, and padlock hasps inside and outside.
  
- G. Safety Railing System: Roof-hatch manufacturer's standard system including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction.
  1. Height: 42 inches above finished roof deck.
  2. Posts and Rails: Galvanized-steel pipe, 1-1/4 inches in diameter or galvanized-steel tube, 1-5/8 inches in diameter.
  3. Flat Bar: Galvanized steel, 2 inches high by 3/8 inch thick.
  4. Maximum Opening Size: System constructed to prevent passage of a sphere 21 inches in diameter.
  5. Self-Latching Gate: Fabricated of same materials and rail spacing as safety railing system. Provide manufacturer's standard hinges and self-latching mechanism.
  6. Post and Rail Tops and Ends: Weather resistant, closed or plugged with prefabricated end fittings.
  7. Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members.
  8. Fabricate joints exposed to weather to be watertight.
  9. Fasteners: Manufacturer's standard, finished to match railing system.

10. Finish: Manufacturer's standard.

a. Color: As selected by Architect from manufacturer's full range.

H. Ladder-Assist Post: Roof-hatch manufacturer's standard device for attachment to roof-access ladder.

1. Operation: Post locks in place on full extension; release mechanism returns post to closed position.

2. Height: 42 inches above finished roof deck.

3. Material: Steel tube.

4. Post: 1-5/8-inch- diameter pipe.

5. Finish: Manufacturer's standard baked enamel or powder coat.

a. Color: As selected by Architect from manufacturer's full range.

## 2.6 PREFORMED FLASHING SLEEVES

A. Vent Stack Flashing: Metal flashing sleeve, uninsulated, with integral deck flange.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by Professional:

a. Custom Solution Roof and Metal Products.

b. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.

c. Thaler Metal USA Inc.

2. Metal: Aluminum sheet, 0.063 inch thick.

3. Height: 7 inches.

4. Diameter: As indicated.

5. Finish: Manufacturer's standard.

## 2.7 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

C. Verify dimensions of roof openings for roof accessories.

- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. General: Install roof accessories according to manufacturer's written instructions.
  - 1. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.
  - 2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
  - 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
  - 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
  - 1. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet, or install a course of polyethylene sheet.
  - 2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.
- C. Roof Curb Installation: Install each roof curb so top surface is level.
- D. Equipment Support Installation: Install equipment supports so top surfaces are level with each other.
- E. Roof-Hatch Installation:
  - 1. Install roof hatch so top surface of hatch curb is level.
  - 2. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
  - 3. Attach safety railing system to roof-hatch curb.
  - 4. Attach ladder-assist post according to manufacturer's written instructions.
- F. Preformed Flashing-Sleeve Installation: Secure flashing sleeve to roof membrane according to flashing-sleeve manufacturer's written instructions.
- G. Seal joints with sealant as required by roof accessory manufacturer.

### 3.3 REPAIR AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780.
- B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
- C. Clean exposed surfaces according to manufacturer's written instructions.

- D. Clean off excess sealants.
- E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

**END OF SECTION 07 72 00**

**SECTION 07 81 00**  
**APPLIED FIREPROOFING**

**PART 1 - GENERAL**

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

- A. Section includes sprayed fire-resistive materials (SFRM).
- B. Related Requirements:

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.
  - 2. Review products, design ratings, restrained and unrestrained conditions, densities, thicknesses, bond strengths, and other performance requirements.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product, including the following:
  - 1. For paints and coatings used on the interior of the building, include printed statement of VOC content in g/L.
- B. Samples: For each exposed product and for each color and texture specified, 4 inches square in size.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of fireproofing.
- B. Evaluation Reports: For fireproofing, from ICC-ES.

## 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by fireproofing manufacturer as experienced and with sufficient trained staff to install manufacturer's products according to specified requirements.

## 1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not apply fireproofing when ambient or substrate temperature is 44 deg F or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.
- B. Ventilation: Ventilate building spaces during and after application of fireproofing, providing complete air exchanges according to manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fireproofing dries thoroughly.

## **PART 2 - PRODUCTS**

### 2.1 MATERIALS, GENERAL

- A. Assemblies: Provide fireproofing, including auxiliary materials, according to requirements of each fire-resistance design and manufacturer's written instructions.
- B. Source Limitations: Obtain fireproofing from single source.
- C. Fire-Resistance Design: Indicated on Drawings, tested according to ASTM E 119 or UL 263 a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Steel members are to be considered unrestrained unless specifically noted otherwise.
- D. VOC Content:
  - 1. Paints and Coatings: Products used on the interior of the building (i.e., inside the weatherproofing system and applied on-site) shall comply with VOC content limits of authorities having jurisdiction and the following VOC limits when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
    - a. Flat Paints and Coatings: 50 g/L.
    - b. Nonflat Paints and Coatings: 150 g/L.
    - c. Primer or Undercoat: 100 g/L.
  - 2. Anticorrosive and Antirust Paints Applied to Interior Ferrous Metal Substrates: Do not exceed the VOC content limit of 250 g/L.
- E. Asbestos: Provide products containing no detectable asbestos.

### 2.2 SPRAYED FIRE-RESISTIVE MATERIALS

- A. SFRM: Manufacturer's standard, factory-mixed, lightweight, dry formulation, complying with indicated fire-resistance design, and mixed with water at Project site to form a slurry or mortar



before conveyance and application or conveyed in a dry state and mixed with atomized water at place of application.

1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by the Professional:
  - a. Carbolite Company; RPM International; Southwest Fireproofing Type 5GP.
  - b. Grace Construction Products; W.R. Grace & Co. -- Conn; Grace Construction Products; Monokote MK-6 or Monokote MK-6/HY.
  - c. Isolatek International, Inc; Cafco 300 or Cafco Blaze-Shield II.
2. Bond Strength: Minimum 150-lbf/sq. ft. cohesive and adhesive strength based on field testing according to ASTM E 736.
3. Density: Not less than 15 lb/cu. ft. and as specified in the approved fire-resistance design, according to ASTM E 605.
4. Thickness: As required for fire-resistance design indicated, measured according to requirements of fire-resistance design or ASTM E 605, whichever is thicker, but not less than 0.3125 inch.
5. Combustion Characteristics: ASTM E 136.
6. Surface-Burning Characteristics: Flame-spread and smoke-developed indexes of 10 or less according to ASTM E 84.
7. Compressive Strength: Minimum 10 lbf/sq. according to ASTM E 761.
8. Corrosion Resistance: No evidence of corrosion according to ASTM E 937.
9. Deflection: No cracking, spalling, or delamination according to ASTM E 759.
10. Effect of Impact on Bonding: No cracking, spalling, or delamination according to ASTM E 760.
11. Air Erosion: Maximum weight loss of 0.025 g/sq. ft. in 24 hours according to ASTM E 859.
12. Fungal Resistance: Treat products with manufacturer's standard antimicrobial formulation to result in no growth on specimens per ASTM G 21 or rating of 10 according to ASTM D 3274 when tested according to ASTM D 3273.
13. Locations: Sprayed fire-resistive materials (SFRM) applied to structural steel beams, columns, bracing, and their connections, where covered by other construction.

## 2.3 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that are compatible with fireproofing and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.
- B. Substrate Primers: Primers approved by fireproofing manufacturer and complying with one or both of the following requirements:
  1. Primer and substrate are identical to those tested in required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
  2. Primer's bond strength in required fire-resistance design complies with specified bond strength for fireproofing and with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction, based on a series of bond tests according to ASTM E 736.
- C. Bonding Agent: Product approved by fireproofing manufacturer and complying with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction.

- D. Topcoat: Suitable for application over applied fireproofing; of type recommended in writing by fireproofing manufacturer for each fire-resistance design.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and according to each fire-resistance design. Verify compliance with the following:
  - 1. Substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable of impairing bond of fireproofing with substrates under conditions of normal use or fire exposure.
  - 2. Objects penetrating fireproofing, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
  - 3. Substrates receiving fireproofing are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fireproofing application.
- B. Verify that concrete work on steel deck has been completed before beginning fireproofing work.
- C. Verify that roof construction, installation of roof-top HVAC equipment, and other related work is complete before beginning fireproofing work.
- D. Conduct tests according to fireproofing manufacturer's written recommendations to verify that substrates are free of substances capable of interfering with bond.
- E. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 PREPARATION**

- A. Cover other work subject to damage from fallout or overspray of fireproofing materials during application. Provide temporary enclosure as required to confine spraying operations, protect the environment, and ensure maintenance of adequate ambient conditions for temperature and ventilation.
- B. Clean substrates of substances that could impair bond of fireproofing.
- C. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of fireproofing. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

#### **3.3 APPLICATION**

- A. Construct fireproofing assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, sealers, topcoats, finishing, and other materials and procedures affecting fireproofing work.

- B. Comply with fireproofing manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fireproofing; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.
  - C. Coordinate application of fireproofing with other construction to minimize need to cut or remove fireproofing.
    - 1. Do not begin applying fireproofing until clips, hangers, supports, sleeves, and other items penetrating fireproofing are in place.
    - 2. Defer installing ducts, piping, and other items that would interfere with applying fireproofing until application of fireproofing is completed.
  - D. Metal Decks:
    - 1. Do not apply fireproofing to underside of metal deck substrates until concrete topping, if any, has been completed.
    - 2. Do not apply fireproofing to underside of metal roof deck until roofing has been completed; prohibit roof traffic during application and drying of fireproofing.
      - a. If roof traffic is anticipated after SFRM application is complete, then specified roof walkways must be installed.
  - E. Install auxiliary materials as required, as detailed, and according to fire-resistance design and fireproofing manufacturer's written recommendations for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by fireproofing manufacturer.
  - F. Spray apply fireproofing to maximum extent possible. Following the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by fireproofing manufacturer.
  - G. Extend fireproofing in full thickness over entire area of each substrate to be protected.
  - H. Install body of fireproofing in a single course unless otherwise recommended in writing by fireproofing manufacturer.
  - I. Where sealers are used, apply products that are tinted to differentiate them from fireproofing over which they are applied.
  - J. Provide a uniform finish complying with description indicated for each type of fireproofing material and matching finish approved for required mockups.
  - K. Cure fireproofing according to fireproofing manufacturer's written recommendations.
  - L. Do not install enclosing or concealing construction until after fireproofing has been applied, inspected, and tested and corrections have been made to deficient applications.
- 3.4 FIELD QUALITY CONTROL
- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
    - 1. Test and inspect as required by the IBC, 1704.10.

2. Test and inspect in accordance with the AWCI "Technical manual 12-A - Standard Practice for the Testing and Inspection of Field-Applied Sprayed Fire-Resistive Materials; an Annotated Guide," most current edition.
- B. Perform the tests and inspections of completed Work in successive stages. Do not proceed with application of fireproofing for the next area until test results for previously completed applications of fireproofing show compliance with requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.
  - C. Fireproofing will be considered defective if it does not pass tests and inspections.
    1. Remove and replace fireproofing that does not pass tests and inspections, and retest.
    2. Apply additional fireproofing, per manufacturer's written instructions, where test results indicate insufficient thickness, and retest.
- 3.5 CLEANING, PROTECTING, AND REPAIRING
- A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.
  - B. Protect fireproofing, according to advice of manufacturer and Installer, from damage resulting from construction operations or other causes, so fireproofing will be without damage or deterioration at time of Substantial Completion.
  - C. As installation of other construction proceeds, inspect fireproofing and repair damaged areas and fireproofing removed due to work of other trades.
  - D. Repair fireproofing damaged by other work before concealing it with other construction.
  - E. Repair fireproofing by reapplying it using same method as original installation or using manufacturer's recommended trowel-applied product.

**END OF SECTION 07 81 00**

## SECTION 07 84 13

### PENETRATION FIRESTOPPING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:

- 1. Penetrations in fire-resistance-rated walls.
- 2. Penetrations in horizontal assemblies.
- 3. Penetrations in smoke barriers.

- B. Related Requirements:

- 1. Section 07 84 46 "Fire-Resistive Joint Systems" for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, including the following:

- 1. For penetration firestopping sealants and sealant primers used on the interior of the building, include a statement of VOC content in g/L.

- B. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency.

- 1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.

- B. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.

- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.
- B. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:
  - 1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
  - 2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:
    - a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
    - b. Classification markings on penetration firestopping correspond to designations listed by the following:
      - 1) UL in its "Fire Resistance Directory."
      - 2) Intertek ETL SEMKO in its "Directory of Listed Building Products."
- C. Preinstallation Conference: Conduct conference at Project site.
  - 1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.

## 1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
- B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

## 1.7 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

- C. Notify Owner's testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by the professional:
  - 1. Grace Construction Products.
  - 2. Hilti, Inc.
  - 3. Nelson Firestop Products.
  - 4. RectorSeal Corporation.
  - 5. Specified Technologies Inc.
  - 6. 3M Fire Protection Products.
  - 7. Tremco, Inc.; Tremco Fire Protection Systems Group.
  - 8. USG Corporation.

### **2.2 PENETRATION FIRESTOPPING**

- A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
- B. Penetrations in Fire-Resistance-Rated Walls: Ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
  - 1. Fire-resistance-rated walls include fire walls, fire-barrier walls, smoke-barrier walls, and fire partitions.
  - 2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- C. Penetrations in Horizontal Assemblies: Ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
  - 1. Horizontal assemblies include floors and ceiling membranes of roof/ceiling assemblies.
  - 2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
  - 3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
- D. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.
  - 1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at 0.30-inch wg at both ambient and elevated temperatures.
- E. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

- F. VOC Content: Penetration firestopping sealants and sealant primers used on the interior of the building shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1. Sealants: 250 g/L.
  2. Sealant Primers for Nonporous Substrates: 250 g/L.
  3. Sealant Primers for Porous Substrates: 775 g/L.
- G. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.
1. Permanent forming/damming/backing materials, including the following:
    - a. Slag-wool-fiber or rock-wool-fiber insulation.
    - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
    - c. Fire-rated form board.
    - d. Fillers for sealants.
  2. Temporary forming materials.
  3. Substrate primers.
  4. Collars.
  5. Steel sleeves.

## 2.3 FILL MATERIALS

- A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
- C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.
- E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
- F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant



additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

- I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
  - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

## 2.4 MIXING

- A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:
  - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
  - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
  - 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

### 3.3 INSTALLATION

- A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
  - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.
- C. Install fill materials for firestopping by proven techniques to produce the following results:
  - 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
  - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
  - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

### 3.4 IDENTIFICATION

- A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
  - 1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
  - 2. Contractor's name, address, and phone number.
  - 3. Designation of applicable testing and inspecting agency.
  - 4. Date of installation.
  - 5. Manufacturer's name.
  - 6. Installer's name.

### 3.5 FIELD QUALITY CONTROL

- A. Where required by code and authorities having jurisdiction, penetration firestopping shall be inspected according to ASTM E 2174, "On-Site Inspection of Installed Fire Stops." Coordinate with third party inspector.
- B. Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- C. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.
- D. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

### 3.6 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

**END OF SECTION 07 84 13**

## SECTION 07 84 46

### FIRE-RESISTIVE JOINT SYSTEMS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:

- 1. Joints in or between fire-resistance-rated constructions.
- 2. Joints at exterior curtain-wall/floor intersections.
- 3. Joints in smoke barriers.

- B. Related Requirements:

- 1. Section 07 84 13 "Penetration Firestopping" for penetrations in fire-resistance-rated walls, horizontal assemblies, and smoke barriers.
- 2. Section 07 95 00 "Expansion Control" for fire-resistive architectural joint systems.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, including the following:

- 1. For fire-resistive joint system sealants and sealant primers used on the interior of the building, include a statement of VOC content in g/L.

- B. Shop Drawings: Submit documentation from a qualified testing and inspection agency that is applicable to each fire-resistive joint system configuration to be installed in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers for construction and linear void width.

- C. Product Schedule: For each fire-resistive joint system. Include location and design designation of qualified testing agency.

- 1. Where Project conditions require modification to a qualified testing agency's illustration for a particular fire-resistive joint system condition, submit illustration, with modifications marked, approved by fire-resistive joint system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.

- B. Installer Certificates: From Installer indicating fire-resistive joint systems have been installed in compliance with requirements and manufacturer's written recommendations.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fire-resistive joint systems.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A firm experienced in installing fire-resistive joint systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its fire-resistive joint system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.
- B. Fire-Test-Response Characteristics: Fire-resistive joint systems shall comply with the following requirements:
  - 1. Fire-resistive joint system tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
  - 2. Fire-resistive joint systems are identical to those tested per testing standard referenced in "Fire-Resistive Joint Systems" Article. Provide rated systems complying with the following requirements:
    - a. Fire-resistive joint system products bear classification marking of qualified testing agency.
    - b. Fire-resistive joint systems correspond to those indicated by reference to designations listed by the following:
      - 1) UL in its "Fire Resistance Directory."
      - 2) Intertek ETL SEMKO in its "Directory of Listed Building Products."
- C. Preinstallation Conference: Conduct conference at Project site.
  - 1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.

## 1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install fire-resistive joint systems when ambient or substrate temperatures are outside limits permitted by fire-resistive joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Install and cure fire-resistive joint systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

## 1.7 COORDINATION

- A. Coordinate construction of joints to ensure that fire-resistive joint systems are installed according to specified requirements.
- B. Coordinate sizing of joints to accommodate fire-resistive joint systems.

- C. Notify Owner's testing agency at least seven days in advance of fire-resistive joint system installations; confirm dates and times on day preceding each series of installations.

## **PART 2 - PRODUCTS**

### **2.1 FIRE-RESISTIVE JOINT SYSTEMS**

- A. Where required, provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which fire-resistive joint systems are installed. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
- B. Joints in or between Fire-Resistance-Rated Construction: Ratings determined per ASTM E 1966 or UL 2079:
  - 1. Joints include those installed in or between fire-resistance-rated walls, floor or floor/ceiling assemblies, and roofs or roof/ceiling assemblies.
  - 2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.
  - 3. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by the Professional:
    - a. A/D Fire Protection Systems Inc.
    - b. Fire Trak Corp.
    - c. Grace Construction Products.
    - d. Hilti, Inc.
    - e. Johns Manville.
    - f. Nelson Firestop Products.
    - g. NUCO Inc.
    - h. Passive Fire Protection Partners.
    - i. RectorSeal Corporation.
    - j. Specified Technologies Inc.
    - k. 3M Fire Protection Products.
    - l. Tremco, Inc.; Tremco Fire Protection Systems Group.
    - m. USG Corporation.
- C. Joints at Exterior Curtain-Wall/Floor Intersections: Rating determined by ASTM E 119 based on testing at a positive pressure differential of 0.01-inch wg or ASTM E 2307.
  - 1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by the professional:
    - a. A/D Fire Protection Systems Inc.
    - b. Grace Construction Products.
    - c. Hilti, Inc.
    - d. Johns Manville.
    - e. Nelson Firestop Products.
    - f. NUCO Inc.
    - g. Passive Fire Protection Partners.
    - h. RectorSeal Corporation.
    - i. Specified Technologies Inc.

- j. 3M Fire Protection Products.
- k. Thermafiber, Inc.
- l. Tremco, Inc.; Tremco Fire Protection Systems Group.
- m. USG Corporation.

D. Joints in Smoke Barriers: Ratings determined per UL 2079.

1. L-Rating: Not exceeding 5.0 cfm/ft of joint at 0.30 inch wg at both ambient and elevated temperatures.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by the Professional:
  - a. A/D Fire Protection Systems Inc.
  - b. Grace Construction Products.
  - c. Hilti, Inc.
  - d. Johns Manville.
  - e. Nelson Firestop Products.
  - f. NUCO Inc.
  - g. Passive Fire Protection Partners.
  - h. RectorSeal Corporation.
  - i. Specified Technologies Inc.
  - j. 3M Fire Protection Products.
  - k. Tremco, Inc.; Tremco Fire Protection Systems Group.
  - l. USG Corporation.

E. Exposed Fire-Resistive Joint Systems: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

F. VOC Content: Fire-resistive joint system sealants and sealant primers used on the interior of the building shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Architectural Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

G. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to maintain ratings required. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing agency for systems indicated.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Cleaning: Clean joints immediately before installing fire-resistive joint systems to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:
  - 1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.
  - 2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.
  - 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by fire-resistive joint system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates.

### 3.3 INSTALLATION

- A. General: Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
  - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.
- C. Install fill materials for fire-resistive joint systems by proven techniques to produce the following results:
  - 1. Fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
  - 2. Apply fill materials so they contact and adhere to substrates formed by joints.
  - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

### 3.4 IDENTIFICATION

- A. Identify fire-resistive joint systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of joint edge so labels will be visible to anyone seeking to remove or penetrate joint system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:



1. The words "Warning - Fire-Resistive Joint System - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

### 3.5 FIELD QUALITY CONTROL

- A. Where required by code and authorities having jurisdiction, fire-resistive joint systems shall be inspected according to ASTM E 2393, "On-Site Inspection of Installed Fire-Resistive Joint Systems." Coordinate with third party inspector.
- B. Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- C. Where deficiencies are found or fire-resistive joint systems are damaged or removed due to testing, repair or replace fire-resistive joint systems so they comply with requirements.
- D. Proceed with enclosing fire-resistive joint systems with other construction only after inspection reports are issued and installations comply with requirements.

### 3.6 CLEANING AND PROTECTING

- A. Clean off excess fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and that do not damage materials in which joints occur.
- B. Provide final protection and maintain conditions during and after installation that ensure fire-resistive joint systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

**END OF SECTION 07 84 46**

## SECTION 07 92 00

### JOINT SEALANTS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:

1. Silicone joint sealants.
2. Nonstaining silicone joint sealants.
3. Urethane joint sealants.
4. Immersible joint sealants.
5. Mildew-resistant joint sealants.
6. Butyl joint sealants.
7. Latex joint sealants.

- B. Related Requirements:

1. Section 07 92 19 "Acoustical Joint Sealants" for sealing joints in sound-rated construction.

##### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product, including the following:

1. For sealants and sealant primers used on the interior of the building, include a statement of VOC content in g/L.

- B. Samples: For each kind and color of joint sealant required.

- C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each kind of joint sealant, for tests performed by a qualified testing agency.
- B. Preconstruction Laboratory Test Reports: From sealant manufacturer, indicating the following:
1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
  2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.
- C. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
- D. Sample Warranties: For special warranties.

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Product Testing: Test joint sealants using a qualified testing agency.
1. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.
- C. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

#### 1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
1. Adhesion Testing: Use ASTM C 794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
  2. Compatibility Testing: Use ASTM C 1087 to determine sealant compatibility when in contact with glazing and gasket materials.
  3. Stain Testing: Use ASTM C 1248 to determine stain potential of sealant when in contact with masonry substrates.

4. Submit manufacturer's recommended number of pieces of each type of material, including joint substrates, joint-sealant backings, and miscellaneous materials.
  5. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
  6. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.
  7. Testing will not be required if joint-sealant manufacturers submit data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, staining of, and compatibility with joint substrates and other materials matching those submitted.
- B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
  2. Conduct field tests for each kind of sealant and joint substrate.
  3. Notify Architect seven days in advance of dates and times when test joints will be erected.
  4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
    - a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1.1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
      - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
  5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
  6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

## 1.8 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
  2. When joint substrates are wet.
  3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
  4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

## 1.9 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two (2) years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
1. Warranty Period: Five (5) years from date of Substantial Completion unless otherwise indicated.
  2. Warranty Period for Silicone Sealants: Ten (10) years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
  2. Disintegration of joint substrates from causes exceeding design specifications.
  3. Mechanical damage caused by individuals, tools, or other outside agents.
  4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

## **PART 2 - PRODUCTS**

### **2.1 JOINT SEALANTS, GENERAL**

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. VOC Content of Interior Sealants: All sealants and sealant primers used on the interior of the building shall comply with the following:
1. Architectural sealants shall have a VOC content of 250 g/L or less.
  2. Sealants and sealant primers for nonporous substrates shall have a VOC content of 250 g/L or less.
  3. Sealants and sealant primers for nonporous substrates shall have a VOC content of 775 g/L or less.
- C. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

### **2.2 SILICONE JOINT SEALANTS**

- A. Silicone, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.
1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by the Professional:
    - a. Dow Corning Corporation; 791 or 795.
    - b. GE Construction Sealants; SCS2000 SilPruf.
    - c. May National Associates, Inc., a subsidiary of Sika Corporation U.S.; Bondaflex Sil 265 LTS.

- d. Pecora Corporation; PCS.
- e. Tremco Incorporated; Spectrem 2.

### 2.3 NONSTAINING SILICONE JOINT SEALANTS

- A. Nonstaining Joint Sealants: No staining of substrates when tested according to ASTM C 1248.
- B. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.
  - 1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by the Professional:
    - a. Dow Corning Corporation; 756 SMS.
    - b. GE Construction Sealants; SilPruf NB.
    - c. May National Associates, Inc., a subsidiary of Sika Corporation U.S.; Bondaflex Sil 295 FPS NB.
    - d. Pecora Corporation; 864NST.
    - e. Tremco Incorporated; Spectrem 3.

### 2.4 URETHANE JOINT SEALANTS

- A. Urethane, S, NS, 25, NT: Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
  - 1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by the professional:
    - a. Bostik, Inc.; Chem-Calk 915.
    - b. Pecora Corporation; Dynatrol I-XL.
    - c. Polymeric Systems, Inc.; Flexiprene 1000.
    - d. Tremco Incorporated; Dymonic.
- B. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT.
  - 1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by the Professional:
    - a. BASF Construction Chemicals, LLC, Building Systems; Sonolastic SL 1.
    - b. Pecora Corporation; NR-201.
    - c. Polymeric Systems, Inc.; Flexiprene 952.
    - d. Schnee-Morehead, Inc.; an ITW company; Permathane SM7101.

### 2.5 IMMERSIBLE JOINT SEALANTS

- A. Immersible Joint Sealants. Suitable for immersion in liquids; ASTM C 1247, Class 1; tested in deionized water unless otherwise indicated

- B. Urethane, Immersible, S, P, 25, T, NT, I: Immersible, single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T, NT, and I.
1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by the Professional:
    - a. Meadows, W. R., Inc.; Pourthane SL.
    - b. Sika Corporation U.S.; Sikaflex 1c SL.
    - c. Tremco Incorporated; Vulkem 45.
- C. Urethane, Immersible, M, P, 25, T, NT, I: Immersible, multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade P, Class 25, Uses T, NT, and I.
1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by the Professional:
    - a. BASF Construction Chemicals, LLC, Building Systems; Sonolastic SL 2.
    - b. LymTal International, Inc.; Iso-Flex 880 GB.
    - c. Sika Corporation U.S.; Sikaflex 2c SL.

## 2.6 MILDEW-RESISTANT JOINT SEALANTS

- A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.
- B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by the Professional:
    - a. Dow Corning Corporation; 786-M White.
    - b. GE Construction Sealants; SCS1700 Sanitary.
    - c. May National Associates, Inc., a subsidiary of Sika Corporation U.S.; Bondaflex Sil 100 WF.
    - d. Tremco Incorporated; Tremsil 200.

## 2.7 BUTYL JOINT SEALANTS

- A. Butyl-Rubber-Based Joint Sealants: ASTM C 1311.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following, or equal approved by the Professional:
    - a. Bostik, Inc.; Chem-Calk 300.
    - b. Pecora Corporation; BC-158.

## 2.8 LATEX JOINT SEALANTS

- A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF, paintable.
  - 1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by the Professional:
    - a. BASF Construction Chemicals, LLC, Building Systems; Sonolac.
    - b. Pecora Corporation; AC-20.
    - c. Tremco Incorporated; Tremflex 834.

## 2.9 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by the Professional:
    - a. Backer Rod Mfg. Inc.
    - b. BASF Construction Chemicals, LLC, Building Systems.
    - c. Construction Foam Products, a division of Nomaco, Inc.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), Type B (bicellular material with a surface skin), or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

## 2.10 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.



## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
  - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
  - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
    - a. Concrete.
    - b. Masonry.
    - c. Unglazed surfaces of ceramic tile.
    - d. Exterior insulation and finish systems.
  - 3. Remove laitance and form-release agents from concrete.
  - 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
    - a. Metal.
    - b. Glass.
    - c. Porcelain enamel.
    - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

### 3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with ASTM C 1193 and joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
  - 1. Do not leave gaps between ends of sealant backings.
  - 2. Do not stretch, twist, puncture, or tear sealant backings.
  - 3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- C. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
  - 1. Place sealants so they directly contact and fully wet joint substrates.
  - 2. Completely fill recesses in each joint configuration.
  - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
  - 1. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.

### 3.4 FIELD QUALITY CONTROL

- A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
  - 1. Extent of Testing: Test completed and cured sealant joints as follows:
    - a. Perform 10 tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.
    - b. Perform one test for each 1000 feet of joint length thereafter or one test per each floor per elevation.
  - 2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
    - a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
  - 3. Inspect tested joints and report on the following:
    - a. Whether sealants filled joint cavities and are free of voids.

- b. Whether sealant dimensions and configurations comply with specified requirements.
    - c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.
  - 4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
  - 5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
- B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

### 3.5 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

### 3.6 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

### 3.7 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.
  - 1. Joint Locations:
    - a. Control and expansion joints in brick pavers.
    - b. Isolation and contraction joints in cast-in-place concrete slabs.
    - c. Joints between plant-precast architectural concrete paving units.
    - d. Tile control and expansion joints.
    - e. Joints between different materials listed above.
    - f. Other joints as indicated on Drawings.
  - 2. Joint Sealant: Urethane, immersible, S, P, 25, T, NT, I.
  - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:
    - a. Construction joints in cast-in-place concrete.
    - b. Joints between plant-precast architectural concrete units.
    - c. Joints in dimension stone cladding.
    - d. Joints in glass unit masonry assemblies.
    - e. Joints in exterior insulation and finish systems.
    - f. Joints between metal panels.
    - g. Joints between different materials listed above.
    - h. Perimeter joints between materials listed above and frames of doors, windows, and louvers.
    - i. Control and expansion joints in ceilings and other overhead surfaces.
    - j. Other joints as indicated on Drawings.
  2. Joint Sealant: Silicone, S, NS, 50, NT.
  3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- C. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Locations:
    - a. Joints between cast stone units.
    - b. Other joints as indicated on Drawings.
  2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT.
  3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- D. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Locations:
    - a. Control and expansion joints in unit masonry.
    - b. Other joints as indicated on Drawings.
  2. Joint Sealant: Urethane, S, NS, 25, NT.
  3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- E. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
1. Joint Locations:
    - a. Isolation joints in cast-in-place concrete slabs.
    - b. Control and expansion joints in stone flooring.
    - c. Control and expansion joints in tile flooring.
    - d. Other joints as indicated on Drawings.
  2. Joint Sealant: Urethane, S, P, 25, T, NT.
  3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- F. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Locations:
    - a. Control and expansion joints on exposed interior surfaces of exterior walls.
    - b. Vertical joints on exposed surfaces of unit masonry walls and partitions.

- c. Other joints as indicated on Drawings.
  2. Joint Sealant: Urethane, S, NS, 25, NT.
  3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- G. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.
  1. Joint Locations:
    - a. Control joints on exposed interior surfaces of exterior walls.
    - b. Perimeter joints between interior wall surfaces and frames of interior doors, windows, and elevator entrances.
    - c. Other joints as indicated on Drawings.
  2. Joint Sealant: Acrylic latex.
- H. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.
  1. Joint Locations:
    - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
    - b. Tile control and expansion joints where indicated.
    - c. Other joints as indicated on Drawings.
  2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
  3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- I. Joint-Sealant Application: Concealed mastics.
  1. Joint Locations:
    - a. Aluminum thresholds.
    - b. Sill plates.
    - c. Other joints as indicated on Drawings.
  2. Joint Sealant: Butyl-rubber based.

**END OF SECTION 07 92 00**

## SECTION 07 92 19

### ACOUSTICAL JOINT SEALANTS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section includes acoustical joint sealants.
- B. Related Requirements:
  - 1. Section 07 92 00 "Joint Sealants" for elastomeric, latex, and butyl-rubber-based joint sealants for nonacoustical applications.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each acoustical joint sealant, including the following:
  - 1. For sealants and sealant primers used on the interior of the building, include a statement of VOC content in g/L.
- B. Samples: For each kind and color of acoustical joint sealant required.
- C. Samples for Verification: For each kind and color of acoustical joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Acoustical-Joint-Sealant Schedule: Include the following information:
  - 1. Joint-sealant application, joint location, and designation.
  - 2. Joint-sealant manufacturer and product name.
  - 3. Joint-sealant formulation.
  - 4. Joint-sealant color.

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each kind of acoustical joint sealant, for tests performed by a qualified testing agency.
- B. Sample Warranties: For special warranties.

## 1.5 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace acoustical joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
  - 1. Warranty Period: Two (2) years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish acoustical joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
  - 1. Warranty Period: Five (5) years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Provide acoustical joint-sealant products that effectively reduce airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies according to ASTM E 90.
- B. VOC Content of Interior Sealants: All sealants and sealant primers used on the interior of the building and shall comply with the following:
  - 1. Acoustical sealants and sealant primers shall have a VOC content of 250 g/L or less.

### 2.2 ACOUSTICAL JOINT SEALANTS

- A. Acoustical Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex acoustical sealant complying with ASTM C 834.
  - 1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by the Professional:
    - a. GE Construction Sealants; RCS20 Acoustical.
    - b. Grabber Construction Products; Acoustical Sealant GSC.
    - c. Pecora Corporation; AC-20 FTR.
    - d. Tremco, Incorporated; Tremco Acoustical Sealant.
    - e. USG Corporation; SHEETROCK Acoustical Sealant.

### 2.3 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by acoustical-joint-sealant manufacturer where required for adhesion of sealant to joint substrates.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine joints indicated to receive acoustical joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 PREPARATION**

- A. Surface Cleaning of Joints: Clean out joints immediately before installing acoustical joint sealants to comply with joint-sealant manufacturer's written instructions.
- B. Joint Priming: Prime joint substrates where recommended by acoustical-joint-sealant manufacturer. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

#### **3.3 INSTALLATION OF ACOUSTICAL JOINT SEALANTS**

- A. Comply with acoustical joint-sealant manufacturer's written installation instructions unless more stringent requirements apply.
- B. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical joint sealant. Install acoustical joint sealants at both faces of partitions, at perimeters, and through penetrations. Comply with ASTM C 919, ASTM C 1193, and manufacturer's written recommendations for closing off sound-flanking paths around or through assemblies, including sealing partitions to underside of floor slabs above acoustical ceilings.
- C. Acoustical Ceiling Areas: Apply acoustical joint sealant at perimeter edge moldings of acoustical ceiling areas in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

#### **3.4 CLEANING**

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of acoustical joint sealants and of products in which joints occur.



### 3.5 PROTECTION

- A. Protect acoustical joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated acoustical joint sealants immediately so installations with repaired areas are indistinguishable from original work.

**END OF SECTION 07 92 19**

**SECTION 07 95 00**  
**EXPANSION CONTROL**

**PART 1 - GENERAL**

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

A. Section Includes:

1. Interior expansion control systems.
2. Exterior wall expansion control systems.

B. Related Requirements:

1. Section 07 71 29 "Manufactured Roof Expansion Joints" for factory-fabricated roof expansion control.
2. Section 07 84 46 "Fire-Resistive Joint Systems" for liquid-applied joint sealants in fire-resistive building joints.
3. Section 07 92 00 "Joint Sealants" for liquid-applied joint sealants and for elastomeric sealants without metal frames.

1.3 ACTION SUBMITTALS

- A. Shop Drawings: For each expansion control system specified. Include plans, elevations, sections, details, splices, blockout requirement, attachments to other work, and line diagrams showing entire route of each expansion control system. Where expansion control systems change planes, provide isometric or clearly detailed drawing depicting how components interconnect.
- B. Samples: For each exposed expansion control system and for each color and texture specified, full width by 6 inches long in size.
- C. Samples for Verification: For each type of expansion control system indicated, full width by 6 inches long in size.
- D. Product Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:
1. Manufacturer and model number for each expansion control system.

2. Expansion control system location cross-referenced to Drawings.
3. Nominal joint width.
4. Movement capability.
5. Classification as thermal or seismic.
6. Materials, colors, and finishes.
7. Product options.
8. Fire-resistance ratings.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each fire barrier provided as part of an expansion control system, for tests performed by a qualified testing agency.

### **PART 2 - PRODUCTS**

#### 2.1 SYSTEM DESCRIPTION

- A. General: Provide expansion control systems of design, basic profile, materials, and operation indicated. Provide units with capability to accommodate variations in adjacent surfaces.
  1. Furnish units in longest practicable lengths to minimize field splicing. Install with hairline mitered corners where expansion control systems change direction or abut other materials.
  2. Include factory-fabricated closure materials and transition pieces, T-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous expansion control systems.
- B. Coordination: Coordinate installation of exterior wall and soffit expansion control systems with roof expansion control systems to ensure that wall transitions are watertight. Roof expansion joint assemblies are specified elsewhere.

#### 2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: Where indicated, provide expansion control systems with fire barriers identical to those of systems tested for fire resistance per UL 2079 or ASTM E 1966 by a testing and inspecting agency acceptable to authorities having jurisdiction.
  1. Hose Stream Test: Wall-to-wall and wall-to-ceiling systems shall be subjected to hose stream testing.

#### 2.3 INTERIOR EXPANSION CONTROL SYSTEMS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated or a comparable product by one of the following, or equal approved by the Professional:

1. Architectural Art Mfg., Inc.; Division of Pittcon Industries.
  2. Balco, Inc.
  3. Construction Specialties, Inc.
  4. JointMaster/InPro Corporation.
  5. MM Systems Corporation.
  6. Nystrom, Inc.
  7. Watson Bowman Acme Corp.; a BASF Construction Chemicals business.
- B. Source Limitations: Obtain expansion control systems from single source from single manufacturer.
- C. Floor-to-Floor:
1. Basis-of-Design Product: Balco; NBR Series – Tile Recessed.
  2. Design Criteria:
    - a. Nominal Joint Width: 2-inch.
    - b. Type of Movement: Thermal.
    - c. Load Capacity:
      - 1) Uniform Load: 150 lb/sq. ft.
      - 2) Concentrated Load: 2000 lb.
      - 3) Maximum Deflection: 1.0 inch.
    - d. Fire-Resistance Rating: Provide expansion control system and fire-barrier assembly with a rating not less than that of adjacent construction.
  3. Type: Cover plate.
    - a. Cover-Plate Design: Recessed to accept field-applied finish materials.
      - 1) Cover-Plate Recess Depth: As required to accommodate adjacent flooring.
    - b. Metal: Aluminum.
      - 1) Finish: Mill.
    - c. Seal Material: Santoprene.
      - 1) Color: Black.
- D. Floor-to-Wall:
1. Basis-of-Design Product: Balco; NBR Series.
  2. Design Criteria:
    - a. Nominal Joint Width: 2-inch.

- b. Type of Movement: Thermal.
  - c. Fire-Resistance Rating: Provide expansion control system and fire-barrier assembly with a rating not less than that of adjacent construction.
3. Type: Cover plate.
- a. Cover-Plate Design: Recessed to accept field-applied finish materials.
    - 1) Cover-Plate Recess Depth: As required to accommodate adjacent flooring.
  - b. Metal: Aluminum.
    - 1) Finish: Mill.
  - c. Seal Material: Santoprene.
    - 1) Color: Black.

E. Wall-to-Wall:

- 1. Basis-of-Design Product: Balco; 75FWG Series.
- 2. Design Criteria:
  - a. Nominal Joint Width: 2- inch.
  - b. Type of Movement: Thermal.
  - c. Fire-Resistance Rating: Provide expansion control system and fire-barrier assembly with a rating not less than that of adjacent construction.
- 3. Type: Elastomeric seal.
  - a. Metal: Aluminum.
    - 1) Finish: Mill.
  - b. Seal Material: Santoprene.
    - 1) Color: Black.

F. Wall Corner:

- 1. Basis-of-Design Product: Balco; 75FWG Series.
- 2. Design Criteria:
  - a. Nominal Joint Width: 2-inch.
  - b. Type of Movement: Thermal.
  - c. Fire-Resistance Rating: Provide expansion control system and fire-barrier assembly with a rating not less than that of adjacent construction.
- 3. Type: Elastomeric seal.
  - a. Metal: Aluminum.

1) Finish: Mill.

b. Seal Material: Santoprene.

1) Color: Black.

G. Wall-to-Ceiling:

1. Basis-of-Design Product: Balco; 75FWG Series.

2. Design Criteria:

a. Nominal Joint Width: 2-inch.

b. Type of Movement: Thermal.

c. Fire-Resistance Rating: Provide expansion control system and fire-barrier assembly with a rating not less than that of adjacent construction.

3. Type: Elastomeric seal.

a. Metal: Aluminum.

1) Finish: Mill.

b. Seal Material: Santopren seal.

1) Color: Black.

H. Ceiling-to-Ceiling:

1. Basis-of-Design Product: Balco; 75FWG Series.

2. Design Criteria:

a. Nominal Joint Width: 2-inch.

b. Type of Movement: Thermal.

c. Fire-Resistance Rating: Provide expansion control system and fire-barrier assembly with a rating not less than that of adjacent construction.

3. Type: Elastomeric seal.

a. Metal: Aluminum.

1) Finish: Mill.

b. Seal Material: Santoprene.

1) Color: Black.

## 2.4 EXTERIOR WALL EXPANSION CONTROL SYSTEMS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated or a comparable product by one of the following, or equal approved by Professional:

1. Architectural Art Mfg., Inc.; Division of Pittcon Industries.

2. Balco, Inc.
  3. Construction Specialties, Inc.
  4. EMSEAL Corporation.
  5. JointMaster/InPro Corporation.
  6. MM Systems Corporation.
  7. Nystrom, Inc.
  8. Watson Bowman Acme Corp.; a BASF Construction Chemicals business.
- B. Source Limitations: Obtain expansion control systems from single source from single manufacturer.
- C. Wall-to-Wall:
1. Basis-of-Design Product: Balco; BCSW Series.
  2. Design Criteria:
    - a. Nominal Joint Width: 2-inch.
    - b. Type of Movement: Thermal.
    - c. Fire-Resistance Rating: Provide expansion control system and fire-barrier assembly with a rating not less than that of adjacent construction.
  3. Type: Preformed cellular foam.
    - a. Foam Material: Manufacturer's standard.
      - 1) Color: As selected by Architect from manufacturer's full range.
- D. Wall-to-Wall:
1. Basis-of-Design Product: Balco; CMX – Low Profile.
  2. Design Criteria:
    - a. Nominal Joint Width: 2-inch.
    - b. Type of Movement: Thermal.
    - c. Fire-Resistance Rating: Provide expansion control system and fire-barrier assembly with a rating not less than that of adjacent construction.
  3. Type: Cover plate.
    - a. Metal: Aluminum.
      - 1) Finish: Mill.

## 2.5 ACCESSORIES

- A. Moisture Barriers: Manufacturer's standard moisture barrier consisting of a continuous, waterproof membrane within joint and attached to substrate on sides of joint below the primary cover. Equip moisture barrier with drain tubes and seals to direct collected moisture to exterior-wall expansion control system.

## 2.6 MATERIALS

- A. Aluminum: ASTM B 221, Alloy 6063-T5 for extrusions; ASTM B 209, Alloy 6061-T6 for sheet and plate.
  - 1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.
- B. Elastomeric Seals: ASTM E 1783; preformed elastomeric membranes or extrusions to be installed in metal frames.
- C. Compression Seals: ASTM E 1612; preformed elastomeric extrusions having an internal baffle system and designed to function under compression.
- D. Cellular Foam Seals: Extruded, compressible foam designed to function under compression.
- E. Elastomeric Concrete: Modified epoxy or polyurethane extended into a prepackaged aggregate blend, specifically designed for bonding to concrete substrates.
- F. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint and to meet performance criteria for required fire-resistance rating.
- G. Moisture Barrier: Flexible elastomeric material.
- H. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.
- I. Accessories: Manufacturer's standard anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

## 2.7 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.



## 2.8 ALUMINUM FINISHES

- A. Mill finish.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Examine surfaces where expansion control systems will be installed for installation tolerances and other conditions affecting performance of work.
  - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Prepare substrates according to expansion control system manufacturer's written instructions.
- B. Coordinate and furnish anchorages, setting drawings, and instructions for installing expansion control systems. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of expansion control systems.

### 3.3 INSTALLATION

- A. Comply with manufacturer's written instructions for storing, handling, and installing expansion control systems and materials unless more stringent requirements are indicated.
- B. Metal Frames: Perform cutting, drilling, and fitting required to install expansion control systems.
  - 1. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
  - 2. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation. Notify Architect where discrepancies occur that will affect proper expansion control system installation and performance.
  - 3. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
  - 4. Repair or grout blockout as required for continuous frame support using nonmetallic, shrinkage-resistant grout.
  - 5. Install frames in continuous contact with adjacent surfaces.
    - a. Shimming is not permitted.
  - 6. Locate anchors at interval recommended by manufacturer, but not less than 3 inches from each end and not more than 24 inches o.c.
- C. Seals in Metal Frames: Install elastomeric seals and membranes in frames to comply with manufacturer's written instructions. Install with minimum number of end joints.
  - 1. Provide in continuous lengths for straight sections.

2. Seal transitions according to manufacturer's written instructions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.
  3. Installation: Mechanically lock seals into frames or adhere to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.
- D. Compression Seals: Apply adhesive or lubricant adhesive as recommended by manufacturer to both frame interfaces before installing compression seals.
  - E. Foam Seals: Install with adhesive recommended by manufacturer.
  - F. Epoxy-Bonded Seals: Pressurize seal for time period and to pressure recommended by manufacturer. Do not overpressurize.
  - G. Terminate exposed ends of expansion control systems with field- or factory-fabricated termination devices.
  - H. Fire-Resistance-Rated Assemblies: Coordinate installation of expansion control system materials and associated work so complete assemblies comply with assembly performance requirements.
    1. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.
  - I. Moisture Barrier: Provide at all exterior joints and where indicated on Drawings. Provide drainage fittings at a maximum of 50 feet or where indicated on Drawings.

### 3.4 PROTECTION

- A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.
- B. Protect the installation from damage by work of other Sections. Where necessary due to heavy construction traffic, remove and properly store cover plates or seals and install temporary protection over expansion control systems. Reinstall cover plates or seals prior to Substantial Completion of the Work.

**END OF SECTION 07 95 00**

## SECTION 08 11 13

### HOLLOW METAL DOORS AND FRAMES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section includes hollow-metal doors and frames.
- B. Related Requirements:
  - 1. Section 08 71 00 "Door Hardware" for door hardware for hollow-metal doors.

##### 1.3 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to SDI A250.8.

##### 1.4 COORDINATION

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

##### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, temperature-rise ratings, and finishes.
- B. Shop Drawings: Include elevations, door edge details, frame profiles, metal thicknesses, preparations for hardware, and other details.
  - 1. Manufacturer's published details can be submitted in lieu of Shop Drawings for hollow-metal work.
- C. Schedule: Prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal work palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
  - 1. Provide additional protection to prevent damage to factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow-metal work vertically under cover at Project site with head up. Place on minimum 4-inch- high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

## **PART 2 - PRODUCTS**

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by Professional:
  - 1. Ceco Door Products; an Assa Abloy Group company.
  - 2. Curries Company; an Assa Abloy Group company.
  - 3. Pioneer Industries, Inc.
  - 4. Republic Doors and Frames.
  - 5. Steelcraft; an Ingersoll-Rand company.
- B. Source Limitations: Obtain hollow-metal work from single source from single manufacturer.

### 2.2 REGULATORY REQUIREMENTS

- A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings and temperature-rise limits indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
  - 1. Smoke- and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.
- B. Fire-Rated, Borrowed-Light Assemblies: Complying with NFPA 80 and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

## 2.3 INTERIOR DOORS AND FRAMES

- A. Construct interior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Standard-Duty Doors and Frames: SDI A250.8, Level 1.
  - 1. Physical Performance: Level C according to SDI A250.4.
  - 2. Doors:
    - a. Type: As indicated in the Door and Frame Schedule.
    - b. Thickness: 1-3/4 inches.
    - c. Face: Uncoated, cold-rolled steel sheet, minimum thickness of 0.032 inch, 20-gage.
    - d. Edge Construction: Model 1, Full Flush.
    - e. Core: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core at manufacturer's discretion.
  - 3. Frames:
    - a. Materials: Uncoated, cold-rolled steel sheet, minimum thickness of 0.042 inch, 18-gage.
    - b. Construction: Face welded.
  - 4. Exposed Finish: Prime.

## 2.4 EXTERIOR HOLLOW-METAL DOORS AND FRAMES

- A. Construct exterior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Heavy-Duty Doors and Frames: SDI A250.8, Level 2.
  - 1. Physical Performance: Level B according to SDI A250.4.
  - 2. Doors:
    - a. Type: As indicated in the Door and Frame Schedule.
    - b. Thickness: 1-3/4 inches
    - c. Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch, 18-gage, with minimum A40 coating.
    - d. Edge Construction: Model 1, Full Flush.
    - e. Core: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core at manufacturer's discretion.
  - 3. Thermal-Rated Doors: Provide doors fabricated with thermal-resistance value (R-value) of not less than 2.1 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.
  - 4. Frames:
    - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, 16-gage, with minimum A40 coating.

- b. Construction: Face welded.
5. Exposed Finish: Prime.

## 2.5 FRAME ANCHORS

- A. Jamb Anchors:
  - 1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch, 18-gage, thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
  - 2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch, 18-gage, thick.
  - 3. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
  - 4. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch-diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
- B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch, 18-gage, and as follows:
  - 1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

## 2.6 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.
- D. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
  - 1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.
- E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- F. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- G. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.
- H. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

- I. Glazing: Comply with requirements in Section 08 80 00 "Glazing."
- J. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

## 2.7 FABRICATION

- A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Hollow-Metal Doors:
  - 1. Fire Door Cores: As required to provide fire-protection and temperature-rise ratings indicated.
  - 2. Vertical Edges for Single-Acting Doors: Bevel edges 1/8 inch in 2 inches.
  - 3. Top Edge Closures: Close top edges of doors with inverted closures, except provide flush closures at exterior doors of same material as face sheets.
  - 4. Bottom Edge Closures: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets.
  - 5. Exterior Doors: Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
- C. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
  - 1. Sidelight Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
  - 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
  - 3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
  - 4. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.
  - 5. Jamb Anchors: Provide number and spacing of anchors as follows:
    - a. Masonry Type: Locate anchors not more than 16 inches from top and bottom of frame. Space anchors not more than 32 inches o.c., to match coursing, and as follows:
      - 1) Two anchors per jamb up to 60 inches high.
      - 2) Three anchors per jamb from 60 to 90 inches high.
      - 3) Four anchors per jamb from 90 to 120 inches high.
      - 4) Four anchors per jamb plus one additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.
    - b. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

- 1) Three anchors per jamb up to 60 inches high.
  - 2) Four anchors per jamb from 60 to 90 inches high.
  - 3) Five anchors per jamb from 90 to 96 inches high.
  - 4) Five anchors per jamb plus one additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
- c. Compression Type: Not less than two anchors in each frame.
  - d. Postinstalled Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.
6. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
    - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
    - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
- D. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.
- E. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
  2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.
- F. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow-metal work.
  2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
  3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
  4. Provide loose stops and moldings on inside of hollow-metal work.
  5. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.

## 2.8 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
  1. Shop Primer: SDI A250.10.

## 2.9 ACCESSORIES

- A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
- B. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.



## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

### **3.3 INSTALLATION**

- A. General: Install hollow-metal work plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.
- B. Hollow-Metal Frames: Install hollow-metal frames of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.
  - 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
    - a. At fire-rated openings, install frames according to NFPA 80.
    - b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
    - c. Install frames with removable stops located on secure side of opening.
    - d. Install door silencers in frames before grouting.
    - e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
    - f. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
    - g. Field apply bituminous coating to backs of frames that will be filled with grout containing antifreezing agents.
  - 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
  - 3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation inside frames.
  - 4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.

5. Concrete Walls: Solidly fill space between frames and concrete with mineral-fiber insulation.
  6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
  7. In-Place Metal or Wood-Stud Partitions: Secure slip-on drywall frames in place according to manufacturer's written instructions.
  8. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
    - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
    - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- C. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.
1. Non-Fire-Rated Steel Doors:
    - a. Between Door and Frame Jambs and Head: 1/8 inch plus or minus 1/32 inch.
    - b. Between Edges of Pairs of Doors: 1/8 inch to 1/4 inch plus or minus 1/32 inch.
    - c. Between Bottom of Door and Top of Threshold: 3/8 inch maximum.
    - d. Between Bottom of Door and Top of Finish Floor (No Threshold): 3/4 inch maximum.
    - e. Between Door Face and Stop: 1/16 inch to 1/8 inch plus or minus 1/32 inch.
  2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
  3. Smoke-Control Doors: Install doors and gaskets according to NFPA 105.
- D. Glazing: Comply with installation requirements in Section 08 80 00 "Glazing" and with hollow-metal manufacturer's written instructions.
1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

### 3.4 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.
- B. Remove grout and other bonding material from hollow-metal work immediately after installation.
- C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

**END OF SECTION 08 11 13**

**SECTION 08 14 16**  
**FLUSH WOOD DOORS**

**PART 1 - GENERAL**

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

A. Section Includes:

1. Solid-core doors with wood-veneer faces for transparent finish.
2. Factory finishing solid-core wood doors.
3. Factory fitting flush wood doors to frames and factory machining for hardware.

B. Related Requirements:

1. Section 08 80 00 "Glazing" for glass view panels in flush wood doors.
2. Section 09 91 23 "Interior Painting" for field finishing doors.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of door. Include details of core and edge construction and trim for openings. Include factory-finishing specifications.

1. For adhesives and composite wood products, indicate that product contains no added urea formaldehyde resins.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and the following:

1. Dimensions and locations of blocking.
2. Dimensions and locations of mortises and holes for hardware.
3. Dimensions and locations of cutouts.
4. Undercuts.
5. Fire-protection ratings for fire-rated doors.

- C. Samples: For factory-finished doors.
- D. Samples for Verification:
  - 1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish.
  - 2. Corner sections of doors, approximately 8 by 10 inches, with door faces and edges representing actual materials to be used.
    - a. Provide Samples for each species of veneer and solid lumber required.
    - b. Provide Samples for each color, texture, and pattern of plastic laminate required.
    - c. Finish veneer-faced door Samples with same materials proposed for factory-finished doors.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.
- B. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

#### 1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is a certified participant in AWI's Quality Certification Program.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in plastic bags or cardboard cartons.
- C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

#### 1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during remainder of construction period.

#### 1.9 WARRANTY

- A. A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
    - b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.

2. Warranty Period for Solid-Core Interior Doors: Life of installation.
3. Warranty Period for Hollow-Core Interior Doors: Two (2) years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 FLUSH WOOD DOORS, GENERAL**

- A. Quality Standard: In addition to requirements specified, comply with AWI's "Architectural Woodwork Standards."
  1. Provide AWI Quality Certification Labels indicating that doors comply with requirements of grades specified.
- B. Low-Emitting Materials: Fabricate doors with adhesives and composite wood products that do not contain added urea formaldehyde resins.
- C. WDMA I.S.1-A Performance Grade:
  1. Heavy Duty unless otherwise indicated.
  2. Extra Heavy Duty: Public toilets, janitor's closets, assembly spaces, and exits.
  3. Standard Duty: Closets (not including janitor's closets), and private toilets.
- D. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
  1. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.
  2. Cores: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
  3. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
  4. Pairs: Provide formed-steel edges and astragals with intumescent seals.
    - a. Finish steel edges and astragals with baked enamel same color as doors.
- E. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control, based on testing according to UL 1784.
- F. Structural-Composite-Lumber-Core Doors:
  1. Structural Composite Lumber: WDMA I.S.10.
    - a. Screw Withdrawal, Face: 700 lbf.
    - b. Screw Withdrawal, Edge: 400 lbf.

### **2.2 VENEER-FACED DOORS FOR TRANSPARENT FINISH**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by Professional:

1. Algoma Hardwoods, Inc.
2. Eggers Industries.
3. Graham Wood Doors; ASSA ABLOY Group company.
4. Marshfield DoorSystems, Inc.
5. Mohawk Doors.
6. Oshkosh Door Company.
7. Vancouver Door Company.
8. VT Industries Inc.

B. Source Limitations: Obtain veneer-faced doors for transparent finish from single manufacturer.

C. Interior Solid-Core Doors:

1. Grade: Custom (Grade A faces).
2. Species: Select white maple.
  - a. Stained to match PL-1 in Finish Legend
3. Cut: Plain sliced (flat sliced).
4. Match between Veneer Leaves: Slip match.
5. Assembly of Veneer Leaves on Door Faces: Balance match.
6. Pair and Set Match: Provide for doors hung in same opening.
7. Exposed Vertical Edges: Same species as faces or a compatible species - edge Type A.
8. Core: Either glued wood stave or structural composite lumber.
9. Construction: Five or seven plies. Stiles and rails are bonded to core, then entire unit is abrasive planed before veneering. Faces are bonded to core using a hot press.

## 2.3 LIGHT FRAMES AND LOUVERS

A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads unless otherwise indicated.

1. Wood Species: Same species as door faces.
2. Profile: Flush rectangular beads.
3. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use.

B. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048-inch- thick, cold-rolled steel sheet; factory primed for paint finish; and approved for use in doors of fire-protection rating indicated.

C. Metal Louvers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by Professional:
  - a. Air Louvers Inc.; a Division of the Activar Construction Products Group.
  - b. Anemostat Products.
  - c. L & L Louvers, Inc.
  - d. Louvers & Dampers, Inc.
  - e. McGill Architectural Products.
2. Blade Type: Vision-proof, inverted V.
3. Metal and Finish: Hot-dip galvanized steel, 0.040 inch thick, factory primed for paint finish.
4. Metal and Finish: Extruded aluminum with Class II, clear anodic finish, AA-M12C22A31.

## 2.4 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
  - 1. Comply with NFPA 80 requirements for fire-rated doors.
- B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, BHMA-156.115-W, and hardware templates.
- C. Openings: Factory cut and trim openings through doors.
  - 1. Light Openings: Trim openings with moldings of material and profile indicated.
  - 2. Louvers: Factory install louvers in prepared openings.

## 2.5 FACTORY FINISHING

- A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
  - 1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.
- B. Factory finish doors that are indicated to receive transparent finish.
- C. Transparent Finish:
  - 1. Grade: Custom.
  - 2. Finish: WDMA TR-4 conversion varnish or WDMA TR-6 catalyzed polyurethane.
  - 3. Staining: As selected by Architect from manufacturer's full range.
  - 4. Effect: Open-grain finish.
  - 5. Sheen: Satin.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine doors and installed door frames, with Installer present, before hanging doors.
  - 1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
  - 2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Hardware: For installation, see Section 08 71 00 "Door Hardware."

- B. Installation Instructions: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
  - 1. Install fire-rated doors according to NFPA 80.
  - 2. Install smoke- and draft-control doors according to NFPA 105.
  
- C. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
  - 1. Clearances: Provide 1/8 inch at heads, jambs, and between pairs of doors. Provide 1/2 inch from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide 1/4 inch from bottom of door to top of threshold unless otherwise indicated.
    - a. Comply with NFPA 80 for fire-rated doors.
  - 2. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.
  - 3. Bevel fire-rated doors 1/8 inch in 2 inches at lock edge; trim stiles and rails only to extent permitted by labeling agency.
  
- D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
  
- E. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

### 3.3 ADJUSTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.
  
- B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

**END OF SECTION 08 14 16**



## SECTION 08 31 13

### ACCESS DOORS AND FRAMES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section includes access doors and frames for walls and ceilings.
- B. Related Requirements:
  - 1. Section 07 72 00 "Roof Accessories" for roof hatches.
  - 2. Section 23 33 00 "Air Duct Accessories" for heating and air-conditioning duct access doors.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, fire ratings, materials, individual components and profiles, and finishes.
- B. Product Schedule: Provide complete access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

#### PART 2 - PRODUCTS

##### 2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics according to the following test method and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
  - 1. NFPA 252 or UL 10B for fire-rated access door assemblies installed vertically.
  - 2. NFPA 288 for fire-rated access door assemblies installed horizontally.

##### 2.2 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by Professional:

1. Acudor Products, Inc.
  2. J. L. Industries, Inc.; Div. of Activar Construction Products Group.
  3. Karp Associates, Inc.
  4. Larsen's Manufacturing Company.
  5. MIFAB, Inc.
  6. Milcor Inc.
  7. Nystrom, Inc.
  8. Williams Bros. Corporation of America (The).
- B. Source Limitations: Obtain each type of access door and frame from single source from single manufacturer.
- C. Flush Access Doors with Exposed Flanges:
1. Assembly Description: Fabricate door to fit flush to frame. Provide manufacturer's standard-width exposed flange, proportional to door size.
  2. Locations: Wet locations and in masonry, concrete, or ceramic tile surfaces.
  3. Door Size: 12 inch by 12 inch, minimum.
  4. Stainless-Steel Sheet for Door: Nominal 0.062 inch, 16 gage.
    - a. Finish: No. 4.
  5. Frame Material: Same material, thickness, and finish as door.
  6. Hinges: Manufacturer's standard.
  7. Hardware: Lock.
- D. Flush Access Doors with Concealed Flanges:
1. Assembly Description: Fabricate door to fit flush to frame. Provide frame with gypsum board beads for concealed flange installation.
  2. Door Size: 12 inch by 12 inch, minimum.
  3. Uncoated Steel Sheet for Door: Nominal 0.060 inch, 16 gage.
    - a. Finish: Factory prime.
    - b. Locations: Non-rated interior gypsum board assemblies unless otherwise indicated.
  4. Metallic-Coated Steel Sheet for Door: Nominal 0.064 inch, 16 gage.
    - a. Finish: Factory prime.
    - b. Locations: Provide in non-rated gypsum board assemblies where exposed to exterior (such as gypsum soffits) and on interior side of exterior masonry wall construction.
  5. Frame Material: Same material and thickness as door.
  6. Hinges: Manufacturer's standard.
  7. Hardware: Lock.
- E. Fire-Rated, Flush Access Doors with Exposed Flanges:
1. Assembly Description: Fabricate door to fit flush to frame, with a core of mineral-fiber insulation enclosed in sheet metal. Provide self-latching door with automatic closer and interior latch release. Provide manufacturer's standard-width exposed flange, proportional to door size.
  2. Door Size: 12 inch by 12 inch, minimum.

3. Locations: Provide at fire-rated wall and ceiling assemblies.
4. Fire-Resistance Rating: Not less than that of adjacent construction.
5. Temperature-Rise Rating: 250 deg F at the end of 30 minutes.
6. Uncoated Steel Sheet for Door: Nominal 0.036 inch, 20 gage.

a. Finish: Factory prime.

7. Frame Material: Same material, thickness, and finish as door.
8. Hinges: Manufacturer's standard.
9. Hardware: Lock.

F. Hardware:

1. Lock: Cylinder.

a. Lock Preparation: Prepare door panel to accept cylinder specified in Section 08 71 00 "Door Hardware."

## 2.3 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.
- C. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
- D. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.
- E. Rolled-Stainless-Steel Floor Plate: ASTM A 793, manufacturer's standard finish.
- F. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304. Remove tool and die marks and stretch lines or blend into finish.
- G. Frame Anchors: Same type as door face.
- H. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

## 2.4 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access doors to types of supports indicated.

1. For concealed flanges with drywall bead, provide edge trim for gypsum board securely attached to perimeter of frames.
  2. Provide mounting holes in frames for attachment of units to metal or wood framing.
  3. Provide mounting holes in frame for attachment of masonry anchors.
- D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
1. For cylinder locks, furnish two keys per lock and key all locks alike.

## 2.5 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Steel and Metallic-Coated-Steel Finishes:
1. Factory Prime: Apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
- E. Stainless-Steel Finishes:
1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. General: Provide access doors and frames in locations as required to access mechanical, plumbing, fire protection, and electrical devices and controls.
- B. Comply with manufacturer's written instructions for installing access doors and frames.
- C. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

3.3 ADJUSTING

- A. Adjust doors and hardware, after installation, for proper operation.
- B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

**END OF SECTION 08 31 13**

## SECTION 08 33 23

### OVERHEAD COILING DOORS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Insulated service doors.
- B. Related Requirements:
  - 1. Section 05 50 00 "Metal Fabrications" for miscellaneous steel supports.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type and size of overhead coiling door and accessory.
  - 1. Include construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
- B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.
  - 1. Include plans, elevations, sections, and mounting details.
  - 2. Include details of equipment assemblies, and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
  - 4. Include diagrams for power, signal, and control wiring.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Samples for Verification: For each type of exposed finish on the following components, in manufacturer's standard sizes:
  - 1. Curtain slats.
  - 2. Bottom bar.
  - 3. Guides.
  - 4. Brackets.

5. Hood.
6. Locking device(s).
7. Include similar Samples of accessories involving color selection.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For overhead coiling doors to include in maintenance manuals.

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.
  1. Maintenance Proximity: Not more than two (2) hours' normal travel time from Installer's place of business to Project site.
- B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC A117.1.

### **PART 2 - PRODUCTS**

#### 2.1 MANUFACTURERS, GENERAL

- A. Source Limitations: Obtain overhead coiling doors from single source from single manufacturer.
  1. Obtain operators and controls from overhead coiling door manufacturer.

#### 2.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance, Exterior Doors: Capable of withstanding the design wind loads.
  1. Design Wind Load: As indicated on Drawings.
  2. Testing: According to ASTM E 330 or DASMA 108 for garage doors and meeting the acceptance criteria of DASMA 108.
  3. Deflection Limits: Design overhead coiling doors to withstand design wind load without evidencing permanent deformation or disengagement of door components.

#### 2.3 INSULATED SERVICE DOOR ASSEMBLY

- A. Insulated Service Door: Overhead coiling door formed with curtain of interlocking metal slats.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by Professional:

- a. C.H.I. Overhead Doors.
  - b. Cookson Company.
  - c. Cornell Iron Works, Inc.
  - d. McKeon Rolling Steel Door Company, Inc.
  - e. Overhead Door Corporation.
  - f. Southwestern Rolling Steel Door Co.
  - g. Wayne-Dalton Corp.
- B. Operation Cycles: Door components and operators capable of operating for not less than **20,000**. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.
- C. Air Infiltration: Maximum rate of 0.08 cfm/sq. ft. at 15 and 25 mph when tested according to ASTM E 283 or DASMA 105.
- D. Curtain R-Value: 5.0 deg F x h x sq. ft./Btu.
- E. Door Curtain Material: Galvanized steel.
- F. Door Curtain Slats: Flat profile slats of 2-5/8-inch center-to-center height.
- 1. Insulated-Slat Interior Facing: Metal.
- G. Bottom Bar: Two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch thick; fabricated from hot-dip galvanized steel and finished to match door.
- H. Curtain Jamb Guides: Galvanized steel with exposed finish matching curtain slats.
- I. Hood: [Match curtain material and finish] [Galvanized steel] <Insert material>.
- 1. Shape: Round.
  - 2. Mounting: As shown on Drawings.
- J. Locking Devices: Equip door with locking device assembly and chain lock keeper.
- 1. Locking Device Assembly: Single-jamb side locking bars, operable from inside with thumb turn.
- A. Electric Door Operator:
- 1. Usage Classification: Standard duty, up to 25 cycles per hour and up to 90 cycles per day.
  - 2. Operator Location: Front of Hood.
  - 3. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use; moving parts of operator enclosed or guarded if exposed and mounted at 8 feet or lower.
  - 4. Motor Exposure: Interior.
  - 5. Emergency Manual Operation: Push-up type.
  - 6. Control Station(s): Interior mounted.
  - 7. Other Equipment: Audible and visual signals.
- B. Curtain Accessories: Equip door with weatherseals, push/pull handles, and pull-down strap.
- C. Door Finish:



1. Baked-Enamel or Powder-Coated Finish: Color as selected by Architect from manufacturer's full range.
2. Interior Curtain-Slat Facing: Match finish of exterior curtain-slat face.

## 2.4 MATERIALS, GENERAL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.5 DOOR CURTAIN MATERIALS AND CONSTRUCTION

- A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:
  1. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural steel sheet; complying with ASTM A 653/A 653M, with G90 zinc coating; nominal sheet thickness (coated) of 0.028 inch; and as required.
  2. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84 or UL 723. Enclose insulation completely within slat faces.
  3. Metal Interior Curtain-Slat Facing: Match metal of exterior curtain-slat face, with minimum steel thickness of 0.010 inch.
- B. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain.

## 2.6 HOODS

- A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.
  1. Galvanized Steel: Nominal 0.028-inch-, 22 gage thick, hot-dip galvanized steel sheet with G90 zinc coating, complying with ASTM A 653/A 653M.
  2. Exterior-Mounted Doors: Fabricate hood to act as weather protection and with a perimeter sealant-joint-bead profile for applying joint sealant.

## 2.7 LOCKING DEVICES

- A. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.
  1. Lock Cylinders: Cylinders specified in Section 08 71 00 "Door Hardware" and keyed to building keying system.

- B. Chain Lock Keeper: Suitable for padlock.
- C. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

## 2.8 CURTAIN ACCESSORIES

- A. Weatherseals for Exterior Doors: Equip each exterior door with weather-stripping gaskets fitted to entire exterior perimeter of door for a weather-resistant installation unless otherwise indicated.
  - 1. At door head, use 1/8-inch- thick, replaceable, continuous-sheet baffle secured to inside of hood or field- installed on the header.
  - 2. At door jambs, use replaceable, adjustable, continuous, flexible, 1/8-inch- thick seals of flexible vinyl, rubber, or neoprene.
- B. Pull-Down Strap: Provide pull-down straps for doors more than 84 inches high.

## 2.9 COUNTERBALANCING MECHANISM

- A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
- B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, seamless carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. of span under full load.
- C. Counterbalance Spring: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.
  - 1. Fire-Rated Doors: Equip with auxiliary counterbalance spring and prevent tension release from main counterbalance spring when automatic closing device operates.
- D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.
- E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

## 2.10 ELECTRIC DOOR OPERATORS

- A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycles requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.
  - 1. Comply with NFPA 70.

2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V ac or dc.
- B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.
  - C. Motors: Reversible-type motor with controller (disconnect switch) for motor exposure indicated.
    1. Electrical Characteristics:
      - a. Phase: Single phase.
      - b. Volts: 115 V.
      - c. Hertz: 60.
    2. Motor Size: Minimum size as indicated. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. and not more than 12 in./sec., without exceeding nameplate ratings or service factor.
    3. Operating Controls, Controllers, Disconnect Switches, Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
    4. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.
  - D. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.
  - E. Control Station: Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure push-button control labeled "Close."
    1. Interior-Mounted Units: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
  - F. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed **25 lbf**.
  - G. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
  - H. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.
  - I. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with regulatory requirements for accessibility.

## 2.11 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM/NOMMA's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)" for recommendations for applying and designating finishes.

- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## 2.12 STEEL AND GALVANIZED-STEEL FINISHES

- A. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.
- B. Examine locations of electrical connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.
- B. Install overhead coiling doors, hoods, controls, and operators at the mounting locations indicated for each door.
- C. Accessibility: Install overhead coiling doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.
- D. Power-Operated Doors: Install according to UL 325.

### 3.3 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Perform installation and startup checks according to manufacturer's written instructions.
  - 2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

### 3.4 ADJUSTING

- A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion. Lubricate bearings and sliding parts as recommended by manufacturer. Adjust seals to provide tight fit around entire perimeter.

3.5 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of coiling-door Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for door operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
  - 1. Perform maintenance, including emergency callback service, during normal working hours.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

**END OF SECTION 08 33 23**

## SECTION 08 41 13

### ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:

- 1. Exterior and interior storefront framing.
- 2. Storefront framing for window walls.
- 3. Storefront framing for punched openings.
- 4. Exterior and interior manual-swing entrance doors.

- B. Related Requirements:

- 1. Section 08 44 13 "Glazed Aluminum Curtain Walls" for coordinating finish among aluminum fenestration units.
- 2. Section 08 80 00 "Glazing" for insulating glass installed in aluminum-framed entrances and storefronts.

##### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

- 1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- 2. For glazing sealants used on the interior of the building, include a statement of VOC content in g/L.

- B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.

- 1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.

2. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.

C. Samples: For each exposed finish required.

D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

E. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams.

F. Delegated-Design Submittal: For aluminum-framed entrances and storefronts indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and field testing agency.

B. Energy Performance Certificates: NFRC-certified energy performance values for each aluminum-framed entrance and storefront from manufacturer.

C. Product Test Reports: For aluminum-framed entrances and storefronts, for tests performed by a qualified testing agency.

D. Quality-Control Program: Developed specifically for Project, including fabrication and installation, according to recommendations in ASTM C 1401. Include periodic quality-control reports.

E. Source quality-control reports.

F. Sample Warranties: For special warranties.

#### 1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For aluminum-framed entrances and storefronts to include in maintenance manuals.

B. Maintenance Data for Structural Sealant: For structural-sealant-glazed storefront to include in maintenance manuals. Include ASTM C 1401 recommendations for post-installation-phase quality-control program.

#### 1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

- C. Structural-Sealant Glazing: Comply with ASTM C 1401 for design and installation of storefront systems.

## 1.8 MOCKUPS

- A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup of typical wall area as shown on Drawings.
2. Testing shall be performed on mockups according to requirements in "Field Quality Control" Article.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

## 1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
  - a. Structural failures including, but not limited to, excessive deflection.
  - b. Noise or vibration created by wind and thermal and structural movements.
  - c. Deterioration of metals and other materials beyond normal weathering.
  - d. Water penetration through fixed glazing and framing areas.
  - e. Failure of operating components.

2. Warranty Period: Ten (10) years from date of Substantial Completion.

- B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:
  - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
  - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
  - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: Ten (10) years from date of Substantial Completion.



## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, licensed in the Commonwealth of Pennsylvania, to design aluminum-framed entrances and storefronts.
- B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
  - 1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
  - 2. Failure also includes the following:
    - a. Thermal stresses transferring to building structure.
    - b. Glass breakage.
    - c. Noise or vibration created by wind and thermal and structural movements.
    - d. Loosening or weakening of fasteners, attachments, and other components.
    - e. Failure of operating units.
- C. Structural Loads:
  - 1. Wind Loads: As indicated on Drawings.
  - 2. Other Design Loads: As indicated on Drawings.
- D. Deflection of Framing Members: At design wind pressure, as follows:
  - 1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
  - 2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch, whichever is smaller.
    - a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.
  - 3. Cantilever Deflection: Where framing members overhang an anchor point, as follows:
    - a. Perpendicular to Plane of Wall: No greater than 1/240 of clear span plus 1/4 inch for spans greater than 11 feet 8-1/4 inches or 1/175 times span, for spans less than 11 feet 8-1/4 inches.
- E. Structural: Test according to ASTM E 330 as follows:
  - 1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
  - 2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
  - 3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

- F. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
1. Fixed Framing and Glass Area:
    - a. Maximum air leakage of 0.06 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft.
  2. Entrance Doors:
    - a. Pair of Doors: Maximum air leakage of 1.0 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft.
    - b. Single Doors: Maximum air leakage of 0.5 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft.
- G. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft.
- H. Seismic Performance: Aluminum-framed entrances and storefronts shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. Seismic Drift Causing Glass Fallout: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.6 at design displacement and 1.5 times the design displacement.
  2. Vertical Interstory Movement: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.7 at design displacement and 1.5 times the design displacement.
- I. Energy Performance: Certify and label energy performance according to NFRC as follows:
1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.69 Btu/sq. ft. x h x deg F as determined according to NFRC 100.
  2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.35 as determined according to NFRC 200.
  3. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified condensation resistance rating of no less than 15 as determined according to NFRC 500.
- J. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- K. Structural-Sealant Joints:
1. Designed to produce tensile or shear stress of less than 20 psi.
- L. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed storefront system without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.

2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.

## 2.2 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Kawneer North America; Trifab VG 451/451T Storefront System or comparable product by one of the following, or equal approved by Professional:
  1. EFCO Corporation.
  2. Oldcastle BuildingEnvelope.
  3. Tubelite.
  4. United States Aluminum.
  5. YKK AP America Inc.
- B. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing spandrel panels, venting windows and accessories, from single manufacturer.

## 2.3 FRAMING

- A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
  1. Construction: Thermally broken.
    - a. Nonthermal construction and monolithic glass may be provided at interior entrance doors and storefront framing.
  2. Glazing System:
    - a. Retained mechanically with gaskets on four sides.
  3. Glazing Plane: As indicated on Drawings.
  4. Finish: Baked-enamel or powder-coat finish.
  5. Fabrication Method: Field-fabricated stick system.
- B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- D. Materials:
  1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
    - a. Sheet and Plate: ASTM B 209.
    - b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
    - c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
    - d. Structural Profiles: ASTM B 308/B 308M.

2. Internal Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.
  - a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
  - b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
  - c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

## 2.4 INSULATED SPANDREL PANELS

- A. Insulated Spandrel Panels: Laminated, metal-faced flat panels with no deviations in plane exceeding 0.8 percent of panel dimension in width or length.
  1. Overall Panel Thickness: 1 inch.
  2. Exterior Skin: Aluminum.
    - a. Thickness: Manufacturer's standard for finish and texture indicated.
    - b. Finish: Match framing system.
    - c. Texture: Smooth.
    - d. Backing Sheet: 1/8-inch- thick, tempered hardboard.
  3. Interior Skin: Aluminum.
    - a. Thickness: Manufacturer's standard for finish and texture indicated.
    - b. Finish: Matching storefront framing.
    - c. Texture: Smooth.
    - d. Backing Sheet: 1/2-inch- thick, gypsum board with proprietary fire-resistance-rated core.
  4. Thermal Insulation Core: Manufacturer's standard.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  1. Flame-Spread Index: 25 or less.
  2. Smoke-Developed Index: 50 or less.

## 2.5 ENTRANCE DOOR SYSTEMS

- A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing operation.
  1. Door Construction: 2- to 2-1/4-inch overall thickness, with minimum 0.125-inch- thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
    - a. Thermal Construction: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.
  2. Door Design: Wide stile; 5-inch nominal width.

- a. Accessible Doors: Smooth surfaced for width of door in area within 10 inches above floor or ground plane.
- 3. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and preformed gaskets.
  - a. Provide nonremovable glazing stops on outside of door.

## 2.6 ENTRANCE DOOR HARDWARE

- A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 08 71 00 "Door Hardware."
- B. General: Provide entrance door hardware and entrance door hardware sets indicated in "Entrance Door Hardware Sets" Article for each entrance door to comply with requirements in this Section.
  - 1. Entrance Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products complying with BHMA standard referenced.
  - 2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
  - 3. Opening-Force Requirements:
    - a. Egress Doors: Not more than 15 lbf to release the latch and not more than 30 lbf to set the door in motion and not more than 15 lbf to open the door to its minimum required width.
    - b. Accessible Interior Doors: Not more than 5 lbf to fully open door.
- C. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of entrance door hardware are indicated in "Entrance Door Hardware Sets" Article. Products are identified by using entrance door hardware designations as follows:
  - 1. References to BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.
- D. Pivot Hinges: BHMA A156.4, Grade 1.
  - 1. Offset-Pivot Hinges: Provide top, bottom, and intermediate offset pivots at each door leaf.
- E. Continuous-Gear Hinges: Manufacturer's standard with stainless-steel bearings between knuckles, fabricated to full height of door and frame.
- F. Mortise Auxiliary Locks: BHMA A156.5, Grade 1.
- G. Automatic and Self-Latching Flush Bolts: BHMA A156.3, Grade 1.
- H. Panic Exit Devices: BHMA A156.3, Grade 1, listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.
- I. Cylinders: As specified in Section 08 71 00 "Door Hardware."
- J. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.

- K. Operating Trim: BHMA A156.6.
- L. Removable Mullions: BHMA A156.3, extruded aluminum.
  - 1. When used with panic exit devices, provide removable mullions listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305. Use only mullions that have been tested with exit devices to be used.
- M. Closers: BHMA A156.4, Grade 1, with accessories required for a complete installation, sized as required by door size, exposure to weather, and anticipated frequency of use; adjustable to comply with field conditions and requirements for opening force.
- N. Surface-Mounted Holders: BHMA A156.16, Grade 1.
- O. Door Stops: BHMA A156.16, Grade 1, floor or wall mounted, as appropriate for door location indicated, with integral rubber bumper.
- P. Weather Stripping: Manufacturer's standard replaceable components.
  - 1. Compression Type: Made of ASTM D 2000, molded neoprene, or ASTM D 2287, molded PVC.
  - 2. Sliding Type: AAMA 701/702, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.
- Q. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.
- R. Silencers: BHMA A156.16, Grade 1.
- S. Thresholds: BHMA A156.21, raised thresholds beveled with a slope of not more than 1:2, with maximum height of 1/2 inch.

## 2.7 GLAZING

- A. Glazing: Comply with Section 08 80 00 "Glazing."
- B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
- C. Glazing Sealants: As recommended by manufacturer.
- D. Sealants used on the interior of the building shall have a VOC content of 250 g/L.
- E. Structural Glazing Sealants: ASTM C 1184, chemically curing silicone formulation that is compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in storefront system indicated.
  - 1. Color: As selected by Architect from manufacturer's full range of colors.
- F. Weatherseal Sealants: ASTM C 920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system

components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed storefront manufacturers for this use.

1. Color: Match structural sealant.

## 2.8 ACCESSORIES

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
  1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
  2. Reinforce members as required to receive fastener threads.
- B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
  1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
- C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- D. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.

## 2.9 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
  1. Profiles that are sharp, straight, and free of defects or deformations.
  2. Accurately fitted joints with ends coped or mitered.
  3. Physical and thermal isolation of glazing from framing members.
  4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
  5. Provisions for field replacement of glazing from interior for vision glass and exterior for spandrel glazing or metal panels.
  6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- E. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.

- F. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
  - 1. At exterior doors, provide compression weather stripping at fixed stops.
  - 2. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.
- G. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
  - 1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
  - 2. At exterior doors, provide weather sweeps applied to door bottoms.
- H. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.
- I. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

## 2.10 ALUMINUM FINISHES

- A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
  - 1. Color and Gloss: As selected by Architect from manufacturer's full range.

## 2.11 SOURCE QUALITY CONTROL

- A. Structural Sealant: Perform quality-control procedures complying with ASTM C 1401 recommendations including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Prepare surfaces that are in contact with structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.



### 3.3 INSTALLATION

#### A. General:

1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
6. Seal perimeter and other joints watertight unless otherwise indicated.

#### B. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

#### C. Set continuous sill members and flashing in full sealant bed as specified in Section 07 92 00 "Joint Sealants" to produce weathertight installation.

#### D. Install components plumb and true in alignment with established lines and grades.

#### E. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.

#### F. Install glazing as specified in Section 08 80 00 "Glazing."

#### G. Install weatherseal sealant according to Section 07 92 00 "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

#### H. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.

1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

### 3.4 ERECTION TOLERANCES

#### A. Erection Tolerances: Install aluminum-framed entrances and storefronts to comply with the following maximum tolerances:

1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
3. Alignment:
  - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.

- b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
  - c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Field Quality-Control Testing: Perform the following test on representative areas of aluminum-framed entrances and storefronts.
  - 1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
    - a. Perform a minimum of three tests in areas as directed by Architect.
- C. Structural-Sealant Adhesion: Test structural sealant according to recommendations in ASTM C 1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.
  - 1. Test a minimum of two areas on each building facade.
  - 2. Repair installation areas damaged by testing.
- D. Aluminum-framed entrances and storefronts will be considered defective if they do not pass tests and inspections.

**END OF SECTION 08 41 13**

## SECTION 08 41 23

### FIRE RATED ALUMINUM FRAME SYSTEM

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section includes:
1. Fire rated glazing and framing systems for installation as sidelights, borrowed lights, windows, and transoms or wall sections in interior openings
- B. Related Sections:
1. Section 05 50 00 "Metal Fabrications:" Steel attachment members inserts and anchors
  2. Section 07 84 00 "Firestopping:" Firestops between work of this section and other fire resistive assemblies.
  3. Section 07 92 00 – "Joint Sealants" for installation of joint sealants installed with steel fire-rated glazed curtain-wall systems and for sealants to the extent not specified in this Section.
  4. Section 08 11 00 – "Metal Doors and Frames" for fire-rated doors.
  5. Section 08 43 13 – "Aluminum Entrance and Storefronts" for entrance [and storefront] systems installed with steel fire-rated glazed curtain-wall systems
  6. Section 08 71 00 "Door Hardware:" Door hardware other than that provided by the work of this section

##### 1.3 REFERENCES

- A. American Architectural Manufacturers Association (AAMA)
1. AAMA 2603-2002 Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.
  2. AAMA 2604 -2005 Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.
  3. AAMA 2605 -2005 Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
- B. American Society for Testing and Materials (ASTM):
1. Fire safety related:
    - a. ASTM E119: Methods for Fire Tests of Building Construction and Materials.
  2. Material related
    - a. ASTM A 1008/A 1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength, Low Alloy, and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable; 2007.

- b. ASTM A 1011/A 1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2006b.
  - 3. Exterior-related:
    - a. ASTM E 283-04: Test Method for Determining the Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences across the Specimen
    - b. ASTM E 330-02: Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference Procedure A
    - c. ASTM E 331-04: Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
    - d. ASTM E 783-02: Test Method for Field Measurement of Air Leakage through Installed Exterior Windows and Doors
    - e. ASTM E 1105-00: Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform or Cyclic Static Air Pressure Difference
- C. American Welding Society (AWS)
  - 1. AWS D1.3 - Structural Welding Code - Sheet Steel; 2007
- D. Builders Hardware Manufacturers Association, Inc.
  - 1. BHMA A156 - American National Standards for door hardware; 2006 (ANSI/BHMA A156).
- E. Canadian Standards
  - 1. CAN/ULC-S101 Standard Test of Fire Endurance Tests of Building Construction and Materials
  - 2. CAN/ULC-S104 Standard Method of Fire Tests of Door Assemblies
  - 3. CAN/ULC-S106 Standard Method of Fire Tests of Window and Glass Block Assemblies
- F. National Fire Protection Association (NFPA):
  - 1. NFPA 80: Fire Doors and Windows.
  - 2. NFPA 251: Fire Tests of Building Construction & Materials
  - 3. NFPA 252: Fire Tests of Door Assemblies
  - 4. NFPA 257: Fire Test of Window Assemblies
- G. Underwriters Laboratories, Inc. (UL):
  - 1. UL 9: Fire Tests of Window Assemblies.
  - 1. UL 10 B: Fire Tests of Door Assemblies
  - 2. UL 10 C: Positive Pressure Fire Tests of Window & Door Assemblies
  - 3. UL 263: Fire tests of Building Construction and Materials
  - 4. UL-752 Ratings of Bullet-Resistant Materials
- H. American National Standards Institute (ANSI):
  - 1. ANSI Z97.1: Standard for Safety Glazing Materials Used in Buildings
- I. Consumer Product Safety Commission (CPSC):
  - 1. CPSC 16 CFR 1201: Safety Standard for Architectural Glazing Materials
- J. American Society of Civil Engineers (ASCE)
  - 1. ASCE 7 – Minimum Design Loads for Buildings and Other Structures; 2005

#### 1.4 DEFINITIONS

- A. Manufacturer: A firm that produces primary glass, fabricated glass or framing as defined in referenced glazing publications.

## 1.5 SUBMITTALS

- B. Product Data:
  - 1. Technical Information: Submit latest edition of manufacturer's product data providing product descriptions, technical data, Underwriters Laboratories, Inc. listings and installation instructions.
- C. Shop Drawings:
  - 1. Include plans, elevations and details of product showing component dimensions; framing opening requirements, dimensions, tolerances, and attachment to structure
- D. Sustainable Requirements:
  - 1. Living Building Challenge Compliance: Compliant
    - a. I-13 Red List Declaration
- E. Structural Calculations:
  - 1. Provide structural calculations sealed by a licensed professional engineer in the State in Maryland which the project is located; prepared in compliance with referenced documents and these specifications.
- F. Samples. For following products:
  - 1. Glass sample-as provided by manufacturer
  - 2. Sample of frame
  - 3. Verification of sample of selected finish
- G. Glazing Schedule: Use same designations indicated on drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.
- H. Warranties: Submit manufacturer's warranty.
- I. Certificates of compliance from glass and glazing materials manufacturers attesting that glass and glazing materials furnished for project comply with requirements.
  - 1. Separate certification will not be required for glazing materials bearing manufacturer's permanent label designating type and thickness of glass, provided labels represent a quality control program involving a recognized certification agency or independent testing laboratory acceptable to authority having jurisdiction

## 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualifications according to
  - 1. International Accreditation Service for a Type A Third-Party Inspection Body (Field Services ICC-ES Third-Party Inspections Standard Operating Procedures, 00-BL-S0400 and S0401)
  - 2. International Accreditation Service for Testing Body-Building Materials and Systems
    - a. Fire Testing
      - 1) ASTM Standards E 119
      - 2) CPSC Standards 16 CFR 1201
      - 3) NFPA Standards 251, 252, 257
      - 4) UL Standards 9, 10B, 10C, 1784, UL Subject 63
      - 5) BS 476; Part 22: 1987
      - 6) EN 1634-1
      - 7) CAN/ULC Standards S101, S104, S106

- B. Fire-Rated Window Assemblies: Assemblies complying with NFPA 80 that are classified and labeled by UL, for fire ratings indicated, based on testing according to NFPA 257 and UL 9.
- C. Fire-Rated Wall Assemblies: Assemblies complying with ASTM E119 that are classified and labeled by UL, for fire ratings indicated, based on testing in accordance with UL 263, ASTM E119.
- D. Listings and Labels - Fire Rated Assemblies: Under current follow-up service by Underwriters Laboratories® maintaining a current listing or certification. Label assemblies accordance with limits of manufacturer's listing.

#### 1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle under provisions specified by manufacturer.

#### 1.8 PROJECT CONDITIONS

- A. Obtain field measurements prior to fabrication of frame units. If field measurements will not be available in a timely manner coordinate planned measurements with the work of other sections.
  - 1. Note whether field or planned dimensions were used in the creation of the shop drawings.
- B. Coordinate the work of this section with others effected including but not limited to: other interior and/or exterior envelope components and door hardware beyond that provided by this section.

#### 1.9 WARRANTY

- A. Provide standard five-year manufacturer warranty.

### **PART 2 – PRODUCTS**

#### 2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide “Fireframes Aluminum Series” fire-rated frame system as manufactured Technical Glass Products or comparable product by one of the following, or equal approved by Professional:
  - 1. McGrory
  - 2. Frameworks
  - 3. Saffitfirst by GPX
  - 4. Aluflam

#### 2.2 PERFORMANCE REQUIREMENTS

- A. System Description:
1. Steel fire-rated glazed wall and/or window system, dual aluminum cover cap format
    - a. Face widths available:
      - 1) 2"
      - 2) Custom extruded aluminum cover caps
      - 3) Custom stainless steel cover caps
    - b. Duration – Windows Capable of providing a fire rating for 45 and 60 minutes.
    - c. Duration – Walls: Capable of providing a fire rating for 60 minutes.
- B. Structural Performance
1. Design and size the system to withstand structural forces placed upon it without damage or permanent set when tested in accordance with ASTM E330 using load 1.5 times the design wind loads and of 10 seconds in duration.
  2. Positive wind load: as indicated on the drawings.
  3. Negative wind Load: as indicated on the drawings
  4. Member deflection: Limit deflection of the edge of the glass normal to the plane of the glass to 1/175 of the glass edge length or 3/4 inch, whichever is less of any framing member
  5. Accommodate movement between storefront and adjoining systems
- C. Air Infiltration: ASTM E 283; Air infiltration rate shall not exceed 0.06 cfm/ft<sup>2</sup> at a static air pressure differential of 6.24 psf.
- D. Water Resistance, (static): ASTM E 331; No leakage at a static air pressure differential of 15 psf as defined in AAMA 501.

### 2.3 MATERIALS - GLASS

- A. Low-E Coated glass for use in insulated exterior units See Section 08 80 00
- B. Fire Rated Glazing: Composed of multiple sheets of high visible light transmission glass laminated with an intumescent interlayer.
- C. Impact Safety Resistance: ANSI Z97.1 and CPSC 16CFR1201(Cat. I and II).
- D. Properties Interior Glazing

Fire-Rating	45 minute	60 minute		120 minute
Glazing type	single	single	single	IGU
Nominal Thickness	3/4" (19mm)	7/8" (23mm)	1-1/16" (27mm)	2-1/4" (57mm)
Weight in lbs/sf	9.2	10.85	12.5	22.9
Daylight Transmission	86	87%	86%	75%
Sound Transmission Coefficient	40dB	41dB	44dB	46dB

- E. Exterior Grade: PVB inner layer installed toward exterior.
- F. Logo: Each piece of fire-rated glazing shall be labeled with a permanent logo including name of product, manufacture, testing laboratory (UL), fire rating period, safety glazing standards, and date of manufacture.

- G. Glazing Accessories: Manufacturer's standard compression gaskets, standoff, spacers, setting blocks and other accessories necessary for a complete installation.

## 2.4 MATERIALS –ALUMINUM FRAMES

- A. Aluminum Framing System 45 min. and 60 min.
1. Steel Frame — The steel framing members are made of two halves, nom. 1.9 in. wide (48.3 mm) with a nom. minimum depth of 1.38 in. (35 mm) with lengths cut according to glazing size.
  2. Aluminum Trim — Supplied with the steel framing members. Nom. 2 in. (50.8 mm) wide with a nom. depth of 1.54 in. (39 mm) with lengths cut according to glazing size.
  3. Stainless Steel Standoffs — Supplied with the steel framing members. Nom 5/16 in. (8 mm) diameter with a nom. minimum depth of 1 1/8 in. (28 mm) with depth adjusted to match Pilkington Pyrostop® Panel thickness.
  4. Stainless Steel Moment and Connecting Braces: — Supplied with the steel framing members. Nom 3/8 in. (10 mm) thick with a nom. minimum depth of 1 1/8 in. (28 mm) with depth adjusted to match Pilkington Pyrostop® Panel thickness.
  5. Framing Member Fasteners — Supplied with the steel framing members. Screws are M6 x16mm Button Head Socket Cap Screws for frame assembly and #6 x 1" Pan Head Sheet Metal Screws for door installation.
  6. Glazing Gasket —
    - a. Interior Gasketing-Supplied with the steel framing members. Nom. 3/4 in. (19 mm) x 3/16 (4.5 mm) black applied to the steel framing members to cushion and seal the glazing material when installed.
    - b. Exterior Gasketing- Supplied with the steel framing members. Nom. 2 in. (50 mm) x 3/16 (4.5 mm) black applied to the steel framing members to cushion and seal the glazing material when installed.
- B. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
1. Extruded Bars, Rods, Shapes, and Tubes: ASTM B 221 (ASTM B 221M).
- C. Steel Reinforcement: With manufacturer's standard corrosion-resistant primer complying with SSPC-PS Guide No. 12.00 applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M Standard Specification for Carbon Structural Steel
  2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable
  3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
- D. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
1. Where fasteners are subject to loosening or turn out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
  2. Reinforce members as required to receive fastener threads.

## 2.5 ACCESSORIES



- A. Fasteners: Use fasteners fabricated from Type 304 or Type 316 stainless steel.
- B. Glazing Gaskets:
  - 1. Glazing gaskets for interior or exterior applications: ASTM C 864 (extruded EPDM rubber that provides for silicone adhesion) or ASTM C1115 Standard Specification for Dense Elastomeric Silicone Rubber Gaskets and Accessories (extruded silicone).
- C. Intumescent Tape: As supplied by frame manufacturer.
- D. Setting Blocks: ¼" Calcium silicate.
- E. Perimeter Anchors: Steel.
- F. Flashings: As recommended by manufacturer; same material and finish as cover caps.
- G. Silicone Sealant: One-Part Low Modulus, neutral cure High Movement-Capable Sealant: Type S; Grade NS; Class 25 with additional movement capability of 100 percent in extension and 50 percent in compression (total 150 percent); Use (Exposure) NT; Uses (Substrates) M, G, A, and O as applicable. (Use-O joint substrates include: Metal factory-coated with a high-performance coating; galvanized steel; ceramic tile.)
  - 1. Available Products:
    - a. Dow Corning 790, 795 - Dow Corning Corp.
    - b. Momentive
    - c. Tremco
- H. Intumescent Caulk: Single component, latex-based, intumescent caulk designed to stop passage of fire, smoke, and fumes through fire-rated separations; permanently flexible after cure; will not support mold growth; flame spread/smoke developed 10/10.
  - 1. Available Products:
    - a. 3M CP-25 WP+

## 2.6 SLAG-WOOL-FIBER/ROCK-WOOL-FIBER INSULATION

- A. Available Manufacturers:
  - 1. Fibrex Insulations Inc.
  - 2. Owens Corning
  - 3. Thermafiber.
  - 4. Rockwool
- B. Unfaced, Slag-Wool-Fiber/Rock-Wool-Fiber Board Insulation: ASTM C 612, maximum flame-spread and smoke-developed indexes of 15 and 0, respectively; passing ASTM E 136 for combustion characteristics; and of the following nominal density and thermal resistivity:
  - 1. Nominal density of 4 lb/cu. ft. (64 kg/cu. m), Types IA and IB, thermal resistivity of 4 deg F x h x sq. ft./Btu x in. at 75 deg F (27.7 K x m/W at 24 deg C).
  - 2. Fiber Color: Regular color, unless otherwise indicated.

## 2.7 FABRICATION

- A. Obtain reviewed shop drawings prior to fabrication.
- B. Fabrication Dimensions: Fabricate fire-rated assembly to field dimensions.
- C. Factory prepared, fire-rated steel door assemblies by TGP to be prehung, prefinished with hardware preinstalled for field mounting.

- D. Field glaze door and frame assemblies.

## 2.8 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish frames after assembly.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable. Noticeable variations in the same piece are not acceptable.

## 2.9 FINISHES

- D. Finish after fabrication.

- E. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable. Noticeable variations in the same piece are not acceptable.

- F. Aluminum Finishes

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Site Verification of Conditions: Verify substrate conditions (which have been previously installed under other sections) are acceptable for product installation in accordance with manufacturer's instructions. Verify openings are sized to receive curtain wall system and sill plate is level in accordance with manufacturer's acceptable tolerances.
- B. Notify Architect of any conditions which jeopardize the integrity of the proposed fire wall / door system.
- C. Do not proceed until such conditions are corrected.

### 3.2 INSTALLATION

- A. General:
  1. Comply with manufacturer's written instructions.
  2. Do not install damaged components.
  3. Fit joints to produce hairline joints free of burrs and distortion.
  4. Rigidly secure nonmovement joints.

5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
  6. Seal perimeter and other joints watertight unless otherwise indicated.
- B. Metal Protection:
1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
  2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- C. Set continuous sill members and flashing in full sealant bed as specified in Section 07 92 00 "Joint Sealants" to produce weathertight installation.
- D. Install components plumb and true in alignment with established lines and grades.
- E. Install glazing as specified in Section 08 88 13 "Fire-Rated Glazing."

### 3.3 REPAIR AND TOUCH UP

- A. Anodized Finishes
1. Protect the anodized finish from harsh chemicals such as concrete/mortar or muriatic acid/brick wash. If reasonable care is taken during handling and high and low pH chemicals can be avoided, repair and/or touch-up of an anodize finish will not be needed.
  2. Some rub marks on an anodized surface can be removed with a mild abrasive pad such as a Scotch-Brite pad prior to touch up painting.
  3. Touch-up paint should be used even more sparingly over anodize. Only the visible raw aluminum in the scratch or gouge should be touched up with a matching paint.
- B. Powder Coated Finishes
1. Limited to minor repair of small scratches. Use only manufacturer's recommended products.
  2. Such repairs shall match original finish for quality or material and view.
  3. Repairs and touch-up not visible from a distance of 5 feet Owner and Architect to approve.
- C. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged.

### 3.4 PROTECTION AND CLEANING

- A. Protect glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.
1. Do not clean with astringent cleaners. Use a clean "grit free" cloth and a small amount of mild soap and water or mild detergent.
  2. Do not use any of the following:
    - a. Steam jets
    - b. Abrasives
    - c. Strong acidic or alkaline detergents, or surface-reactive agents
    - d. Detergents not recommended in writing by the manufacturer
    - e. Do not use any detergent above 77 degrees F

- f. Organic solvents including but not limited to those containing ester, ketones, alcohols, aromatic compounds, glycol ether, or halogenated hydrocarbons.
  - g. Metal or hard parts of cleaning equipment must not touch the glass surface
- B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove them immediately as recommended by glass manufacturer.
- C. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended by glass manufacturer.

**END OF SECTION**

## SECTION 08 42 29.23

### SLIDING AUTOMATIC ENTRANCES

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.2 SUMMARY

- A. Section includes exterior and interior, sliding, power-operated automatic entrances.
- B. Related Requirements:
  - 1. Section 03 30 00 "Cast-in-Place Concrete" for forming recesses in concrete for recessed thresholds.
  - 2. Section 08 71 13 "Automatic Door Operators" for automatic door operators furnished separately from doors and frames.

##### 1.3 DEFINITIONS

- A. AAADM: American Association of Automatic Door Manufacturers.
- B. Activation Device: A control that, when actuated, sends an electrical signal to the door operator to open the door.
- C. IBC: International Building Code.
- D. Safety Device: A control that, to avoid injury, prevents a door from opening or closing.
- E. For automatic door terminology, refer to BHMA A156.10 for definitions of terms.

##### 1.4 COORDINATION

- A. Coordinate sizes and locations of recesses in concrete floors for recessed sliding tracks that control automatic entrances. Concrete, reinforcement, and formwork requirements are specified elsewhere.
- B. Templates: Distribute for doors, frames, and other work specified to be factory prepared for installing automatic entrances.
- C. Coordinate hardware with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish. Coordinate hardware for automatic entrances with hardware required for rest of Project.
- D. Electrical System Roughing-in: Coordinate layout and installation of automatic entrances with connections to power supplies and access-control system.

## 1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.
  - 2.

## 1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for automatic entrances.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For automatic entrances.
  - 1. Include plans, elevations, sections, hardware mounting heights, and attachment details.
  - 2. Include diagrams for power, signal, and control wiring.
  - 3. Indicate locations of activation and safety devices.
  - 4. Include hardware schedule and indicate hardware types, functions, quantities, and locations.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- E. Delegated-Design Submittal: For automatic entrances, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

## 1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturer.
- B. Product Certificates: For each type of automatic entrance. Include emergency-exit features of automatic entrances serving as a required means of egress.
- C. Sample Warranties: For manufacturer's special warranties.

## 1.8 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For automatic entrances, safety devices, and control systems to include in operation and maintenance manuals.

## 1.9 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer with company certificate issued by AAADM indicating that manufacturer has a Certified Inspector on staff.

- B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation and maintenance of units required for this Project.
  - 1. Maintenance Proximity: Not more than two (2) hours' normal travel time from Installer's place of business to Project site.
- C. Certified Inspector Qualifications: Certified by AAADM.

#### 1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of automatic entrances that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including, but not limited to, excessive deflection.
    - b. Faulty operation of operators, controls, and hardware.
    - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
  - 2. Warranty Period: Two (2) years from date of Substantial Completion.
- B. Special Finish Warranty: Manufacturer agrees to repair or replace components on which finishes fail in materials or workmanship within specified warranty period.
  - 1. Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Warranty Period: Ten (10) years from date of Substantial Completion.

### **PART 2 - PRODUCTS**

#### 2.1 AUTOMATIC ENTRANCE ASSEMBLIES

- A. Source Limitations: Obtain sliding automatic entrances from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Power-Operated Door Standard: BHMA A156.10.

#### 2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, licensed in the Commonwealth of Pennsylvania, to design automatic entrances.

- B. Structural Performance: Automatic entrances shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
  - 1. Seismic Loads: As indicated on Drawings.
- C. Wind Loads: As indicated on Drawings.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- E. Operating Temperature Range: Automatic entrances shall operate within minus 20 to plus 122 deg F.
- F. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of 1.25 cfm/sq. ft. of fixed entrance-system area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 1.57 lbf/sq. ft.
- G. Opening Force:
  - 1. Power-Operated Doors: Not more than 50 lbf required to manually set door in motion if power fails, and not more than 15 lbf required to open door to minimum required width.
  - 2. Breakaway Device for Power-Operated Doors: Not more than 50 lbf required for a breakaway door or panel to open.
- H. Entrapment-Prevention Force:
  - 1. Power-Operated Sliding Doors: Not more than 30 lbf required to prevent stopped door from closing.

## 2.3 SLIDING AUTOMATIC ENTRANCES

- A. General: Provide manufacturer's standard automatic entrances including doors, sidelites, framing, headers, carrier assemblies, roller tracks, door operators, controls, and accessories required for a complete installation.
- B. Sliding Automatic Entrance:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by Professional:
    - a. Biparting-Sliding Units:
      - 1) Besam Entrance Solutions; Subsidiary of ASSA ABLOY Entrance Systems.
      - 2) DORMA Automatics; Division of DORMA Group North America.
      - 3) Horton Automatics; a division of Overhead Door Corporation.
      - 4) Nabco Entrances Inc.
      - 5) Stanley Access Technologies, LLC; Division of Stanley Security Solutions.
      - 6) Tormax Technologies, Inc.
  - 2. Configuration: Biparting-sliding door(s) with transom and pocketed sidelite(s).



- a. Traffic Pattern: Two way.
  - b. Emergency Breakaway Capability: Sliding leaves and sidelite.
  - c. Mounting: Between jambs.
3. Operator Features:
- a. Power opening and closing.
  - b. Drive System: Chain or belt.
  - c. Adjustable opening and closing speeds.
  - d. Adjustable hold-open time between zero and 30 seconds.
  - e. Obstruction recycle.
  - f. On-off/hold-open switch to control electric power to operator, key operated.
4. Sliding-Door Carrier Assemblies and Overhead Roller Tracks: Carrier assembly that allows vertical adjustment; consisting of nylon- or delrin-covered, ball-bearing-center steel wheels operating on a continuous roller track, or ball-bearing-center steel wheels operating on a nylon- or delrin-covered, continuous roller track. Support doors from carrier assembly by cantilever and pivot assembly.
- a. Rollers: Minimum of two ball-bearing roller wheels and two antirise rollers for each active leaf.
5. Sliding-Door Threshold: Threshold members and bottom-guide-track system with stainless-steel, ball-bearing-center roller wheels.
- a. Configuration (Exterior Sliding Doors): Saddle-type threshold across door opening and surface-mounted guide-track system at sidelites.
  - b. Configuration (Interior Sliding Doors): No threshold across door opening and surface-mounted guide-track system at sidelites.
6. Controls: Activation and safety devices as indicated on Drawings and according to BHMA standards.
- a. Activation Device: Motion sensor mounted on each side of door header to detect pedestrians in activating zone to activate door operator.
  - b. Safety Device: Presence sensor mounted on each side of door header and two photoelectric beams mounted in sidelite jambs on one side of the door to detect pedestrians in presence zone and to prevent door from closing.
  - c. Combination Activation and Safety Device (Exterior Sliding Doors): Combination motion/presence sensor.
  - d. Combination Activation and Safety Device (Interior Sliding Doors): Controlled by access control system specified in Division 28.
7. Finish: Finish framing, door(s), and header with finish matching adjacent storefront.
- a. Color: As selected by Architect from full range of industry colors and color densities.

## 2.4 ENTRANCE COMPONENTS

- A. Framing Members: Extruded aluminum, minimum 0.125 inch thick and reinforced as required to support imposed loads.
  - 1. Nominal Size: 1-3/4 by 4-1/2 inches.

2. Extruded Glazing Stops and Applied Trim: Minimum 0.062-inch wall thickness.
- B. Stile and Rail Doors: 1-3/4-inch- thick, glazed doors with minimum 0.125-inch- thick, extruded-aluminum tubular stile and rail members. Mechanically fasten corners with reinforcing brackets that are welded, or incorporate concealed tie-rods that span full length of top and bottom rails.
1. Glazing Stops and Gaskets: Snap-on, extruded-aluminum stops and preformed gaskets.
  2. Stile Design: Wide stile, more than 4-inch nominal width.
  3. Rail Design: As indicated on Drawings.
- C. Sidelite(s) and Transom: 1-3/4-inch- deep sidelite(s) and transom with minimum 0.125-inch-thick, extruded-aluminum tubular stile and rail members matching door design.
1. Glazing Stops and Gaskets: Same materials and design as for stile and rail door.
- D. Headers: Fabricated from minimum 0.125-inch- thick extruded aluminum and extending full width of automatic entrance units to conceal door operators and controls. Provide hinged or removable access panels for service and adjustment of door operators and controls. Secure panels to prevent unauthorized access.
1. Mounting: Concealed, with one side of header flush with framing.
  2. Capacity: Capable of supporting doors up to 175 lb per leaf over spans up to 14 feet without intermediate supports.
    - a. Provide sag rods for spans exceeding 14 feet.
- E. Brackets and Reinforcements: High-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- F. Signage: As required by cited BHMA standard.
1. Application Process: Decals.

## 2.5 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
1. Extrusions: ASTM B 221.
  2. Sheet: ASTM B 209.
- B. Steel Reinforcement: Reinforcement with corrosion-resistant primer complying with SSPC-PS Guide No. 12.00 applied immediately after surface preparation and pretreatment. Use surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
- C. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, stretcher-leveled standard of flatness, in entrance manufacturer's standard thickness.
- D. Glazing: As specified in Section 08 80 00 "Glazing."
- E. Sealants and Joint Fillers: As specified in Section 07 92 00 "Joint Sealants."

- F. Nonmetallic, Shrinkage-Resistant Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout; complying with ASTM C 1107/C 1107M; of consistency suitable for application.
- G. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.
- H. Fasteners and Accessories: Corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

## 2.6 DOOR OPERATORS AND CONTROLS

- A. General: Provide operators and controls, which include activation and safety devices, according to BHMA standards, for condition of exposure, and for long-term, maintenance-free operation under normal traffic load for type of occupancy indicated.
- B. Door Operators: Provide door operators of size recommended by manufacturer for door size, weight, and movement.
  - 1. Door Operator Performance: Door operators shall open and close doors and maintain them in fully closed position when subjected to Project's design wind loads.
  - 2. Electromechanical Operators: Concealed, self-contained, overhead unit powered by fractional-horsepower, permanent-magnet dc motor; with closing speed controlled mechanically by gear train and dynamically by braking action of electric motor; with solid-state microprocessor controller; UL 325; and with manual operation with power off.
- C. Motion Sensors: Self-contained, K-band-frequency, microwave-scanner units; fully enclosed by its plastic housing; adjustable to provide detection-field sizes and functions required by BHMA A156.10.
  - 1. Provide capability for switching between bidirectional and unidirectional detection.
  - 2. For one-way traffic, sensor on egress side shall not be active when doors are fully closed.
- D. Presence Sensors: Self-contained, active-infrared scanner units; adjustable to provide detection-field sizes and functions required by BHMA A156.10. Sensors shall remain active at all times.
- E. Combination Motion/Presence Sensors: Self-contained units; consisting of both motion and presence sensors in a single metal or plastic housing; adjustable to provide detection field sizes and functions required by BHMA A156.10.
  - 1. Motion Sensor: K-band-frequency, microwave-scanner units; with relay hold time of not less than 2 to 10 seconds.
    - a. Provide capability for switching between bidirectional and unidirectional detection.
    - b. For one-way-traffic entrances, sensor on egress side shall not be active when doors are fully closed.
  - 2. Presence Sensor: Infrared-scanner units; with relay hold time of not less than 2 to 10 seconds. Sensors shall remain active at all times.
- F. Electrical Interlocks: Unless units are equipped with self-protecting devices or circuits, provide electrical interlocks to prevent activation of operator when door is locked, latched, or bolted.

## 2.7 HARDWARE

- A. General: Provide units in sizes and types recommended by automatic entrance and hardware manufacturers for entrances and uses indicated. Finish exposed parts to match door finish unless otherwise indicated.
- B. Breakaway Device for Power-Operated Doors: Device that allows door to swing out in direction of egress to full 90 degrees from any operating position. Interrupt powered operation of door operator while in breakaway mode.
- C. Deadlocks: Deadbolt operated by exterior cylinder and interior thumb turn, with minimum 1-inch-long throw bolt; BHMA A156.5, Grade 1.
  - 1. Cylinders: As specified in Section 08 71 00 "Door Hardware."
    - a. Keying: Integrate into building master key system.
  - 2. Deadbolts: Laminated Steel, mortise type, BHMA A156.5, Grade 1.
- D. Weather Stripping: Replaceable components.
  - 1. Sliding Type: AAMA 701, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.

## 2.8 FABRICATION

- A. General: Factory fabricate automatic entrance components to designs, sizes, and thicknesses indicated and to comply with indicated standards.
  - 1. Form aluminum shapes before finishing.
  - 2. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
  - 3. Use concealed fasteners to greatest extent possible. Where exposed fasteners are required, use countersunk Phillips flat-head machine screws, finished to match framing.
    - a. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
    - b. Reinforce members as required to receive fastener threads.
  - 4. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
- B. Framing: Provide automatic entrances as prefabricated assemblies. Complete fabrication, assembly, finishing, hardware application, and other work before shipment to Project site.
  - 1. Fabricate tubular and channel frame assemblies with welded or mechanical joints. Provide subframes and reinforcement as required for a complete system to support required loads.
  - 2. Perform fabrication operations in manner that prevents damage to exposed finish surfaces.
  - 3. Form profiles that are sharp, straight, and free of defects or deformations.
  - 4. Provide components with concealed fasteners and anchor and connection devices.

5. Fabricate components with accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion.
  6. Fabricate exterior components to drain condensation and water passing joints within system to the exterior.
  7. Provide anchorage and alignment brackets for concealed support of assembly from building structure.
  8. Allow for thermal expansion of exterior units.
- C. Doors: Factory fabricated and assembled in profiles indicated. Reinforce as required to support imposed loads and for installing hardware.
- D. Door Operators: Factory fabricated and installed in headers, including adjusting and testing.
- E. Glazing: Fabricate framing with minimum glazing edge clearances for thickness and type of glazing indicated, according to GANA's "Glazing Manual."
- F. Hardware: Factory install hardware to greatest extent possible; remove only as required for final finishing operation and for delivery to and installation at Project site. Cut, drill, and tap for factory-installed hardware before applying finishes.
1. Provide sliding-type weather stripping, mortised into door, at perimeter of doors and breakaway sidelites.
- G. Controls:
1. General: Factory install activation and safety devices in doors and headers as required by BHMA A156.10 for type of door and direction of travel.

## 2.9 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## 2.10 ALUMINUM FINISHES

- A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, header support, and other conditions affecting performance of automatic entrances.

- B. Examine roughing-in for electrical systems to verify actual locations of power connections before automatic entrance installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. General: Install automatic entrances according to manufacturer's written instructions and cited BHMA standard for direction of pedestrian travel, including signage, controls, wiring, and connection to the building's power supply.
  - 1. Do not install damaged components. Fit frame joints to produce hairline joints free of burrs and distortion. Rigidly secure nonmovement joints. Seal joints watertight.
  - 2. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
  - 3. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous coating.
- B. Entrances: Install automatic entrances plumb and true in alignment with established lines and grades without warp or rack of framing members and doors. Anchor securely in place.
  - 1. Install surface-mounted hardware using concealed fasteners to greatest extent possible.
  - 2. Set headers, carrier assemblies, tracks, operating brackets, and guides level and true to location with anchorage for permanent support.
  - 3. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within system to exterior.
  - 4. Level recesses for recessed thresholds using nonshrink grout.
- C. Door Operators: Connect door operators to electrical power distribution system.
- D. Access-Control Devices: Connect access-control devices to access-control system as specified in Section 28 13 00 "Access Control."
- E. Controls: Install and adjust activation and safety devices according to manufacturer's written instructions and cited BHMA standard for direction of pedestrian travel. Connect control wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- F. Glazing: Install glazing as specified in Section 08 80 00 "Glazing."
- G. Sealants: Comply with requirements specified in Section 07 92 00 "Joint Sealants" to provide weathertight installation.
  - 1. Set thresholds, bottom-guide-track system, framing members and flashings in full sealant bed.
  - 2. Seal perimeter of framing members with sealant.
- H. Signage: Apply signage on both sides of each door and breakaway sidelite as required by cited BHMA standard for direction of pedestrian travel.
- I. Wiring within Automatic Entrance Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's written limitations on bending radii. Provide and use lacing bars and distribution spools.

### 3.3 FIELD QUALITY CONTROL

- A. Certified Inspector: Owner will engage a Certified Inspector to test and inspect components, assemblies, and installations, including connections.
- B. Automatic entrances will be considered defective if they do not pass tests and inspections.

### 3.4 ADJUSTING

- A. Adjust hardware, moving parts, door operators, and controls to function smoothly, and lubricate as recommended by manufacturer; comply with requirements of applicable BHMA standards.
  - 1. Adjust exterior doors for weathertight closure.
- B. Readjust door operators and controls after repeated operation of completed installation equivalent to three days' use by normal traffic (100 to 300 cycles).
- C. Occupancy Adjustments: When requested within twelve (12) months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two (2) visits to Project during other-than-normal occupancy hours for this purpose.

### 3.5 CLEANING

- A. Clean glass and metal surfaces promptly after installation. Remove excess glazing and sealant compounds, dirt, and other substances. Repair damaged finish to match original finish.
  - 1. Comply with requirements in Section 08 80 00 "Glazing" for cleaning and maintaining glass.

### 3.6 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include twelve (12) months' full maintenance by skilled employees of automatic entrance Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper automatic entrance operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
  - 1. Engage a Certified Inspector to perform safety inspection after each adjustment or repair and at end of maintenance period. Furnish completed inspection reports to Owner.
  - 2. Perform maintenance, including emergency callback service, during normal working hours.

### 3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain automatic entrances.

**END OF SECTION 08 42 29.23**

## SECTION 08 44 13

### GLAZED ALUMINUM CURTAIN WALLS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section includes glazed aluminum curtain walls.
- B. Related Requirements:
  - 1. Section 08 41 13 "Aluminum-Framed Entrances and Storefronts" for coordinating finish among aluminum fenestration units
  - 2. Section 08 80 00 "Glazing" for insulating glass installed in aluminum curtain wall framing.

##### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.

##### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For glazed aluminum curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.
  - 1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
  - 2. Include full-size isometric details of each vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:



- a. Joinery, including concealed welds.
  - b. Anchorage.
  - c. Expansion provisions.
  - d. Glazing.
  - e. Flashing and drainage.
3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
- C. Samples: For each exposed finish required.
- D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- E. Delegated-Design Submittal: For glazed aluminum curtain walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and professional engineer.
- B. Energy Performance Certificates: NFRC-certified energy performance values from manufacturer.
- C. Product Test Reports: For glazed aluminum curtain walls, for tests performed by a qualified testing agency.
- D. Source quality-control reports.
- E. Sample Warranties: For special warranties.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For glazed aluminum curtain walls to include in maintenance manuals.

#### 1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
  - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

## 1.9 MOCKUPS

- A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
  - 1. Build mockup of typical wall area as shown on Drawings.
  - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

## 1.10 WARRANTY

- A. Special Assembly Warranty: Manufacturer agrees to repair or replace components of glazed aluminum curtain wall that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including, but not limited to, excessive deflection.
    - b. Noise or vibration created by wind and thermal and structural movements.
    - c. Deterioration of metals and other materials beyond normal weathering.
    - d. Water penetration through fixed glazing and framing areas.
    - e. Failure of operating components.
  - 2. Warranty Period: Ten (10) years from date of Substantial Completion.
- B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Warranty Period: Ten (10) years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, licensed in the Commonwealth of Pennsylvania, to design glazed aluminum curtain walls.
- B. General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
  - 1. Glazed aluminum curtain walls shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
  - 2. Failure also includes the following:

- a. Thermal stresses transferring to building structure.
- b. Glass breakage.
- c. Noise or vibration created by wind and thermal and structural movements.
- d. Loosening or weakening of fasteners, attachments, and other components.
- e. Failure of operating units.

C. Structural Loads:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.

D. Deflection of Framing Members: At design wind pressure, as follows:

1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch, whichever is smaller.
  - a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.

E. Structural: Test according to ASTM E 330 as follows:

1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

F. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:

1. Fixed Framing and Glass Area:
  - a. Maximum air leakage of 0.06 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft.

G. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft.

H. Energy Performance: Certify and label energy performance according to NFRC as follows:

1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.69 Btu/sq. ft. x h x deg F as determined according to NFRC 100.
2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.35 as determined according to NFRC 200.
3. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified condensation resistance rating of no less than 15 as determined according to NFRC 500.

- I. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

## 2.2 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Kawneer North America; 1600 Wall System 1 or comparable product by one of the following, or equal approved by Professional:
  - 1. EFCO Corporation.
  - 2. Kawneer North America.
  - 3. Oldcastle, Inc.
  - 4. Tubelite.
  - 5. United States Aluminum.
  - 6. YKK AP America Inc.
- B. Source Limitations: Obtain all components of curtain wall system, including framing spandrel panels and accessories, from single manufacturer.

## 2.3 FRAMING

- A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
  - 1. Construction: Thermally broken.
  - 2. Glazing System:
    - a. Retained mechanically with gaskets on four sides.
  - 3. Glazing Plane: As indicated on Drawings.
  - 4. Finish: Baked-enamel or powder-coat finish.
  - 5. Fabrication Method: Either factory- or field-fabricated system.
- B. Pressure Caps: Manufacturer's standard aluminum components that mechanically retain glazing.
  - 1. Include snap-on aluminum trim that conceals fasteners.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- D. Materials:
  - 1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
    - a. Sheet and Plate: ASTM B 209.
    - b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
    - c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
    - d. Structural Profiles: ASTM B 308/B 308M.

2. Internal Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.
  - a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
  - b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
  - c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

## 2.4 INSULATED SPANDREL PANELS

- A. Insulated Spandrel Panels: Laminated, metal-faced flat panels with no deviations in plane exceeding 0.8 percent of panel dimension in width or length.
  1. Overall Panel Thickness: 1 inch.
  2. Exterior Skin: Aluminum.
    - a. Thickness: Manufacturer's standard for finish and texture indicated.
    - b. Finish: Match framing system.
    - c. Texture: Smooth.
    - d. Backing Sheet: 1/8-inch- thick, tempered hardboard.
  3. Interior Skin: Aluminum.
    - a. Thickness: Manufacturer's standard for finish and texture indicated.
    - b. Finish: Matching curtain-wall framing.
    - c. Texture: [Smooth.
    - d. Backing Sheet: 1/8-inch- thick, tempered hardboard.
  4. Thermal Insulation Core: Manufacturer's standard rigid, closed-cell, polyisocyanurate board.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  1. Flame-Spread Index: 25 or less.
  2. Smoke-Developed Index: **50** or less.

## 2.5 GLAZING

- A. Glazing: Comply with Section 08 80 00 "Glazing."
- B. Glazing Gaskets: Comply with Section 08 80 00 "Glazing."
- C. Glazing Sealants: Comply with Section 08 80 00 "Glazing."
- D. Weatherseal Sealants: ASTM C 920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed curtain-wall manufacturers for this use.
  1. Color: Match structural sealant.

## 2.6 ACCESSORIES

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
  - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
  - 2. Reinforce members as required to receive fastener threads.
- B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
- C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- D. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.

## 2.7 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
  - 1. Profiles that are sharp, straight, and free of defects or deformations.
  - 2. Accurately fitted joints with ends coped or mitered.
  - 3. Physical and thermal isolation of glazing from framing members.
  - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
  - 5. Provisions for field replacement of glazing from exterior.
  - 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Fabricate components to resist water penetration as follows:
  - 1. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
- E. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

## 2.8 ALUMINUM FINISHES

- A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: **As selected by Architect from manufacturer's full range.**

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 INSTALLATION**

- A. General:
  1. Comply with manufacturer's written instructions.
  2. Do not install damaged components.
  3. Fit joints to produce hairline joints free of burrs and distortion.
  4. Rigidly secure nonmovement joints.
  5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
  6. Where welding is required, weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
  7. Seal joints watertight unless otherwise indicated.
- B. Metal Protection:
  1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with primer, applying sealant or tape, or installing nonconductive spacers as recommended by manufacturer for this purpose.
  2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
- D. Install components plumb and true in alignment with established lines and grades.
- E. Install glazing as specified in Section 08 80 00 "Glazing."

#### **3.3 ERECTION TOLERANCES**

- A. Erection Tolerances: Install glazed aluminum curtain walls to comply with the following maximum tolerances:
  1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
  2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
  3. Alignment:
    - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.

- b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
  - c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

#### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Field Quality-Control Testing: Perform the following test on representative areas of glazed aluminum curtain walls.
  - 1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
    - a. Perform a minimum of **three** tests in areas as directed by Architect.
  - 2. Air Infiltration: ASTM E 783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft.
    - a. Perform a minimum of **[three] <Insert number>** tests in areas as directed by Architect.
  - 3. Water Penetration: ASTM E 1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft., and shall not evidence water penetration.
- C. Glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.

**END OF SECTION 08 44 13**



## SECTION 08 71 00

### DOOR HARDWARE

#### PART 1 - GENERAL

##### 1.01 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.02 SUMMARY

###### A. Section includes:

- 1. Mechanical and electrified door hardware
- 2. Electronic access control system components

###### B. Section excludes:

- 1. Windows
- 2. Cabinets (casework), including locks in cabinets
- 3. Signage
- 4. Toilet accessories
- 5. Overhead doors

###### C. Related Sections:

- 1. Division 01 Section "Alternates" for alternates affecting this section.
- 2. Division 06 Section "Rough Carpentry"
- 3. Division 06 Section "Finish Carpentry"
- 4. Division 07 Section "Joint Sealants" for sealant requirements applicable to threshold installation specified in this section.
- 5. Division 08 Sections:
  - a. "Metal Doors and Frames"
  - b. "Flush Wood Doors"
  - c. "Interior Aluminum Doors and Frames"
  - d. "Aluminum-Framed Entrances and Storefronts"
- 6. Division 09 sections for touchup, finishing or refinishing of existing openings modified by this section.
- 7. Division 26 "Electrical" sections for connections to electrical power system and for low-voltage wiring.
- 8. Division 28 "Electronic Safety and Security" sections for coordination with other components of electronic access control system and fire alarm system.

##### 1.03 REFERENCES

- A. UL - Underwriters Laboratories

1. UL 10B - Fire Test of Door Assemblies
  2. UL 10C - Positive Pressure Test of Fire Door Assemblies
  3. UL 1784 - Air Leakage Tests of Door Assemblies
  4. UL 305 - Panic Hardware
- B. DHI - Door and Hardware Institute
1. Sequence and Format for the Hardware Schedule
  2. Recommended Locations for Builders Hardware
  3. Keying Systems and Nomenclature
  4. Installation Guide for Doors and Hardware
- C. NFPA – National Fire Protection Association
1. NFPA 70 – National Electric Code
  2. NFPA 80 – 2016 Edition – Standard for Fire Doors and Other Opening Protectives
  3. NFPA 101 – Life Safety Code
  4. NFPA 105 – Smoke and Draft Control Door Assemblies
  5. NFPA 252 – Fire Tests of Door Assemblies
- D. ANSI - American National Standards Institute
1. ANSI A117.1 – 2017 Edition – Accessible and Usable Buildings and Facilities
  2. ANSI/BHMA A156.1 - A156.29, and ANSI/BHMA A156.31 - Standards for Hardware and Specialties
  3. ANSI/BHMA A156.28 - Recommended Practices for Keying Systems
  4. ANSI/WDMA I.S. 1A - Interior Architectural Wood Flush Doors
  5. ANSI/SDI A250.8 - Standard Steel Doors and Frames

#### 1.04 SUBMITTALS

A. General:

1. Submit in accordance with Conditions of Contract and Division 01 Submittal Procedures.
2. Prior to forwarding submittal:
  - a. Comply with procedures for verifying existing door and frame compatibility for new hardware, as specified in PART 3, "EXAMINATION" article, herein.
  - b. Review drawings and Sections from related trades to verify compatibility with specified hardware.
  - c. Highlight, encircle, or otherwise specifically identify on submittals: deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.

B. Action Submittals:

1. Product Data: Submit technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
2. Riser and Wiring Diagrams: After final approval of hardware schedule, submit details of electrified door hardware, indicating:
  - a. Wiring Diagrams: For power, signal, and control wiring and including:

- 1) Details of interface of electrified door hardware and building safety and security systems.
  - 2) Schematic diagram of systems that interface with electrified door hardware.
  - 3) Point-to-point wiring.
  - 4) Risers.
3. Samples for Verification: If requested by Architect, submit production sample of requested door hardware unit in finish indicated and tagged with full description for coordination with schedule.
- a. Samples will be returned to supplier. Units that are acceptable to Architect may, after final check of operations, be incorporated into Work, within limitations of key coordination requirements.
4. Door Hardware Schedule:
- a. Submit concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate fabrication of other work critical in Project construction schedule.
  - b. Submit under direct supervision of a Door Hardware Institute (DHI) certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule published by DHI.
  - c. Indicate complete designations of each item required for each opening, include:
    - 1) Door Index: door number, heading number, and Architect's hardware set number.
    - 2) Quantity, type, style, function, size, and finish of each hardware item.
    - 3) Name and manufacturer of each item.
    - 4) Fastenings and other pertinent information.
    - 5) Location of each hardware set cross-referenced to indications on Drawings.
    - 6) Explanation of all abbreviations, symbols, and codes contained in schedule.
    - 7) Mounting locations for hardware.
    - 8) Door and frame sizes and materials.
    - 9) Degree of door swing and handing.
    - 10) Operational Description of openings with electrified hardware covering egress, ingress (access), and fire/smoke alarm connections.
5. Key Schedule:
- a. After Keying Conference, provide keying schedule that includes levels of keying, explanations of key system's function, key symbols used, and door numbers controlled.
  - b. Use ANSI/BHMA A156.28 "Recommended Practices for Keying Systems" as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
  - c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
  - d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.
  - e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion. Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.
  - f. Prepare key schedule by or under supervision of supplier, detailing Owner's final keying instructions for locks.

C. Informational Submittals:

1. Provide Qualification Data for Supplier, Installer and Architectural Hardware Consultant.
2. Provide Product Data:
  - a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
  - b. Include warranties for specified door hardware.

D. Closeout Submittals:

1. Operations and Maintenance Data: Provide in accordance with Division 01 and include:
  - a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
  - b. Catalog pages for each product.
  - c. Final approved hardware schedule edited to reflect conditions as installed.
  - d. Final keying schedule
  - e. Copy of warranties including appropriate reference numbers for manufacturers to identify project.
  - f. As-installed wiring diagrams for each opening connected to power, both low voltage and 110 volts.

E. Inspection and Testing:

1. Submit written reports to the Owner and Authority Having Jurisdiction (AHJ) of the results of functional testing and inspection for:
  - a. fire door assemblies, in compliance with NFPA 80.
  - b. required egress door assemblies, in compliance with NFPA 101.

## 1.05 QUALITY ASSURANCE

A. Qualifications and Responsibilities:

1. Supplier: Recognized architectural hardware supplier with a minimum of 5 years documented experience supplying both mechanical and electromechanical door hardware similar in quantity, type, and quality to that indicated for this Project. Supplier to be recognized as a factory direct distributor by the manufacturer of the primary materials with a warehousing facility in the Project's vicinity. Supplier to have on staff, a certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) available to Owner, Architect, and Contractor, at reasonable times during the Work for consultation.
2. Installer: Qualified tradesperson skilled in the application of commercial grade hardware with experience installing door hardware similar in quantity, type, and quality as indicated for this Project.
3. Architectural Hardware Consultant: Person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and meets these requirements:
  - a. For door hardware: DHI certified AHC or DHC.
  - b. Can provide installation and technical data to Architect and other related subcontractors.

- c. Can inspect and verify components are in working order upon completion of installation.
    - d. Capable of producing wiring diagram and coordinating installation of electrified hardware with Architect and electrical engineers.
  - 4. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.
- B. Certifications:
- 1. Fire-Rated Door Openings:
    - a. Provide door hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction.
    - b. Provide only items of door hardware that are listed products tested by Underwriters Laboratories, Intertek Testing Services, or other testing and inspecting organizations acceptable to authorities having jurisdiction for use on types and sizes of doors indicated, based on testing at positive pressure and according to NFPA 252 or UL 10C and in compliance with requirements of fire-rated door and door frame labels.
  - 2. Smoke and Draft Control Door Assemblies:
    - a. Provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105
    - b. Comply with the maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at tested pressure differential of 0.3-inch wg (75 Pa) of water.
  - 3. Electrified Door Hardware
    - a. Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction.
  - 4. Accessibility Requirements:
    - a. Comply with governing accessibility regulations cited in "REFERENCES" article 087100, 1.02.D3 herein for door hardware on doors in an accessible route. This project must comply with all Federal Americans with Disability Act regulations and all Local Accessibility Regulations.
- C. Pre-Installation Meetings
- 1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.
  - 2. Keying Conference
    - a. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including:
      - 1) Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
      - 2) Preliminary key system schematic diagram.
      - 3) Requirements for key control system.
      - 4) Requirements for access control.
      - 5) Address for delivery of keys.

3. Pre-installation Conference

- a. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
- b. Inspect and discuss preparatory work performed by other trades.
- c. Inspect and discuss electrical roughing-in for electrified door hardware.
- d. Review sequence of operation for each type of electrified door hardware.
- e. Review required testing, inspecting, and certifying procedures.
- f. Review questions or concerns related to proper installation and adjustment of door hardware.

4. Electrified Hardware Coordination Conference:

- a. Prior to ordering electrified hardware, schedule and hold meeting to coordinate door hardware with security, electrical, doors and frames, and other related suppliers.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site. Promptly replace products damaged during shipping.
- B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package. Deliver each article of hardware in manufacturer's original packaging.
- C. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.
- D. Provide secure lock-up for door hardware delivered to Project. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.
- E. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.
- F. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

1.07 COORDINATION

- A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete.
- B. Installation Templates: Distribute for doors, frames, and other work specified to be factory or shop prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- C. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.
- D. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.
- E. Existing Openings: Where existing doors, frames and/or hardware are to remain, field verify existing functions, conditions and preparations and coordinate to suit opening conditions and to provide proper door operation.

1.08 WARRANTY

- A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within published warranty period.
  - 1. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.
  - 2. Warranty Period: Beginning from date of Substantial Completion, for durations indicated in manufacturer's published listings.
    - a. Mechanical Warranty
      - 1) Locks
        - a) Schlage L Series: 3 years
      - 2) Exit Devices
        - a) Falcon: 10 years
      - 3) Closers
        - a) LCN 4050 Series: 25 years
      - 4) Automatic Operators
        - a) LCN: 2 years
    - b. Electrical Warranty
      - 1) Locks
        - a) Schlage: 1 year
      - 2) Closers
        - a) LCN: 2 years

#### 1.09 MAINTENANCE

- A. Furnish complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.
- B. Turn over unused materials to Owner for maintenance purposes.

## PART 2 - PRODUCTS

#### 2.01 MANUFACTURERS

- A. The Owner requires use of certain products for their unique characteristics and project suitability to ensure continuity of existing and future performance and maintenance standards. After investigating available product offerings, the Awarding Authority has elected to prepare proprietary specifications. These products are specified with the notation: "No Substitute."
  - 1. Where "No Substitute" is noted, submittals and substitution requests for other products will not be considered.
- B. Approval of manufacturers and/or products other than those listed as "Scheduled Manufacturer" or "Acceptable Manufacturers" in the individual article for the product category shall be in accordance with QUALITY ASSURANCE article, herein.
- C. Approval of products from manufacturers indicated in "Acceptable Manufacturers" is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer's product.
- D. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect's approval.

## 2.02 MATERIALS

### A. Fabrication

1. Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. provide screws according to manufacturer's recognized installation standards for application intended.
2. Finish exposed screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work including prepared for paint surfaces to receive painted finish.
3. Provide concealed fasteners wherever possible for hardware units exposed when door is closed. Coordinate with "Metal Doors and Frames", "Flush Wood Doors", "Stile and Rail Wood Doors" to ensure proper reinforcements. Advise the Architect where visible fasteners, such as thru bolts, are required.

### B. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.

1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.

### C. Cable and Connectors:

1. Where scheduled in the hardware sets, provide each item of electrified hardware and wire harnesses with number and gage of wires enough to accommodate electric function of specified hardware.
2. Provide Molex connectors that plug directly into connectors from harnesses, electric locking and power transfer devices.
3. Provide through-door wire harness for each electrified locking device installed in a door and wire harness for each electrified hinge, electrified continuous hinge, electrified pivot, and electric power transfer for connection to power supplies.

## 2.03 HINGES

### A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
  - a. Ives 5BB series
2. Acceptable Manufacturers and Products:
  - a. Hager BB1191/1279 series
  - b. McKinney TB series
  - c. Or equal approved by Professional

### B. Requirements:

1. Provide hinges conforming to ANSI/BHMA A156.1.
2. Provide five knuckle, ball bearing hinges.
3. 1-3/4 inch (44 mm) thick doors, up to and including 36 inches (914 mm) wide:
  - a. Exterior: Standard weight, bronze or stainless steel, 4-1/2 inches (114 mm) high
  - b. Interior: Standard weight, steel, 4-1/2 inches (114 mm) high



4. 1-3/4 inch (44 mm) thick doors over 36 inches (914 mm) wide:
  - a. Exterior: Heavy weight, bronze/stainless steel, 5 inches (127 mm) high
  - b. Interior: Heavy weight, steel, 5 inches (127 mm) high
5. 2 inches or thicker doors:
  - a. Exterior: Heavy weight, bronze or stainless steel, 5 inches (127 mm) high
  - b. Interior: Heavy weight, steel, 5 inches (127 mm) high
6. Adjust hinge width for door, frame, and wall conditions to allow proper degree of opening.
7. Provide three hinges per door leaf for doors 90 inches (2286 mm) or less in height, and one additional hinge for each 30 inches (762 mm) of additional door height.
8. Where new hinges are specified for existing doors or existing frames, provide new hinges of identical size to hinge preparation present in existing door or existing frame.
9. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
  - a. Steel Hinges: Steel pins
  - b. Non-Ferrous Hinges: Stainless steel pins
  - c. Out-Swinging Exterior Doors: Non-removable pins
  - d. Out-Swinging Interior Lockable Doors: Non-removable pins
  - e. Interior Non-lockable Doors: Non-rising pins
10. Provide hinges with electrified options as scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware. Locate electric hinge at second hinge from bottom or nearest to electrified locking component. Provide mortar guard for each electrified hinge specified.

## 2.04 CONTINUOUS HINGES

### A. Manufacturers:

1. Scheduled Manufacturer:
  - a. Ives
2. Acceptable Manufacturers:
  - a. Select
  - b. Stanley
  - c. Or equal approved by Professional

### B. Requirements:

1. Provide aluminum geared continuous hinges conforming to ANSI/BHMA A156.26, Grade 1.
2. Provide aluminum geared continuous hinges, where specified in the hardware sets, fabricated from 6063-T6 aluminum.
3. Provide split nylon bearings at each hinge knuckle for quiet, smooth, self-lubricating operation.
4. Provide hinges capable of supporting door weights up to 450 pounds, and successfully tested for 1,500,000 cycles.
5. On fire-rated doors, provide aluminum geared continuous hinges classified for use on rated doors by testing agency acceptable to authority having jurisdiction.

6. Provide aluminum geared continuous hinges with electrified option scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware.
7. Provide hinges 1 inch (25 mm) shorter in length than nominal height of door, unless otherwise noted or door details require shorter length and with symmetrical hole pattern.

## 2.05 ELECTRIC POWER TRANSFER

### A. Manufacturers:

1. Scheduled Manufacturer and Product:
  - a. Von Duprin EPT-10
2. Acceptable Manufacturers and Products:
  - a. Securitron CEPT-10
  - b. Security Door Controls PTM
  - c. Or equal approved by Professional

### B. Requirements:

1. Provide power transfer with electrified options as scheduled in the hardware sets. Provide with number and gage of wires enough to accommodate electric function of specified hardware.
2. Locate electric power transfer per manufacturer's template and UL requirements, unless interference with operation of door or other hardware items.

## 2.06 FLUSH BOLTS

### A. Manufacturers:

1. Scheduled Manufacturer:
  - a. Ives
2. Acceptable Manufacturers:
  - a. Burns
  - b. Rockwood
  - c. Or equal approved by Professional

### B. Requirements:

1. Provide automatic, constant latching, and manual flush bolts with forged bronze or stainless-steel face plates, extruded brass levers, and with wrought brass guides and strikes. Provide 12 inch (305 mm) steel or brass rods at doors up to 90 inches (2286 mm) in height. For doors over 90 inches (2286 mm) in height increase top rods by 6 inches (152 mm) for each additional 6 inches (152 mm) of door height. Provide dust-proof strikes at each bottom flush bolt.

## 2.07 COORDINATORS

A. Manufacturers:

1. Scheduled Manufacturer:
  - a. Ives
2. Acceptable Manufacturers:
  - a. Rockwood
  - b. DCI
  - c. Or equal approved by Professional

B. Requirements:

1. Where pairs of doors are equipped with automatic flush bolts, an astragal, or other hardware that requires synchronized closing of the doors, provide bar-type coordinating device, surface applied to underside of stop at frame head.
2. Provide filler bar of correct length for unit to span entire width of opening, and appropriate brackets for parallel arm door closers, surface vertical rod exit device strikes, or other stop mounted hardware. Factory-prepared coordinators for vertical rod devices as specified.

## 2.08 MORTISE LOCKS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
  - a. Schlage L9000 series
2. Acceptable Manufacturers and Products:
  - a. Sargent 8200 series
  - b. Or equal approved by Professional

B. Requirements:

1. Provide mortise locks conforming to ANSI/BHMA A156.13 Series 1000, Grade 1, and UL Listed for 3-hour fire doors.
2. Indicators: Where specified, provide indicator window measuring a minimum 2-inch x 1/2 inch with 180-degree visibility. Provide messages color-coded with full text and/or symbols, as scheduled, for easy visibility.
3. Provide locks manufactured from heavy gauge steel, containing components of steel with a zinc dichromate plating for corrosion resistance.
4. Provide lock case that is multi-function and field reversible for handing without opening case. Cylinders: Refer to "KEYING" article, herein.
5. Provide locks with standard 2-3/4 inches (70 mm) backset with full 3/4 inch (19 mm) throw stainless steel mechanical anti-friction latchbolt. Provide deadbolt with full 1-inch (25 mm) throw, constructed of stainless steel.
6. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim. Provide electrified options as scheduled in the hardware sets. Where scheduled, provide switches and sensors integrated into the locks and latches.
7. Provide motor based electrified locksets that comply with the following requirements:

- a. Universal input voltage – single chassis accepts 12 or 24VDC to allow for changes in the field without changing lock chassis.
  - b. Fail Safe/Fail Secure – changing mode between electrically locked (fail safe) and electrically unlocked (fail secure) is field selectable without opening the lock case.
  - c. Low maximum current draw – maximum 0.4 amps to allow for multiple locks on a single power supply.
  - d. Low holding current – maximum 0.01 amps to produce minimal heat, eliminate “hot levers” in electrically locked applications, and to provide reliable operation in wood doors that provide minimal ventilation and air flow.
  - e. Connections – provide quick-connect Molex system standard.
8. Lever Trim: Solid brass, bronze, or stainless steel, cast or forged in design specified, with wrought roses and external lever spring cages. Provide thru-bolted levers with 2-piece spindles.
- a. Vandlgard: Provide levers with vandal resistant technology for use at heavy traffic or abusive applications.
  - b. Lever Design: 06.

## 2.09 EXIT DEVICES

### A. Manufacturers and Products:

- 1. Scheduled Manufacturer and Product:
  - a. Falcon 24/25 series
- 2. Acceptable Manufacturers and Products:
  - a. Sargent 19-43-GL-80 series
  - b. Detex Advantex Series
  - c. Or equal approved by Professional

### B. Requirements:

- 1. Provide exit devices tested to ANSI/BHMA A156.3 Grade 1 and UL listed for Panic Exit or Fire Exit Hardware.
- 2. Cylinders: Refer to "KEYING" article, herein.
- 3. Provide touchpad type exit devices, fabricated of brass, bronze, stainless steel, or aluminum, plated to standard architectural finishes to match balance of door hardware.
- 4. Touchpad must extend a minimum of one half of door width. No plastic inserts are allowed in touchpads.
- 5. Provide exit devices with deadlatching feature for security and for future addition of alarm kits and/or other electrified requirements.
- 6. Provide flush end caps for exit devices.
- 7. Provide exit devices with manufacturer's approved strikes.
- 8. Provide exit devices cut to door width and height. Install exit devices at height recommended by exit device manufacturer, allowable by governing building codes, and approved by Architect.
- 9. Mount mechanism case flush on face of doors or provide spacers to fill gaps behind devices. Where glass trim or molding projects off face of door, provide glass bead kits.
- 10. Provide cylinder or hex-key dogging as specified at non fire-rated openings.

11. Removable Mullions: 2 inches (51 mm) x 3 inches (76 mm) steel tube. Where scheduled as keyed removable mullion, provide type that can be removed by use of a keyed cylinder, which is self-locking when re-installed.
12. Provide factory drilled weep holes for exit devices used in full exterior application, highly corrosive areas, and where noted in hardware sets.
13. Provide electrified options as scheduled.
14. Provide exit devices with optional trim designs to match other lever and pull designs used on the project.

## 2.10 ELECTRIC STRIKES

### A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
  - a. Von Duprin 6000 Series
2. Acceptable Manufacturers and Products:
  - a. Folger Adam 300 Series
  - b. HES 1006 Series
  - c. Or equal approved by Professional.

### B. Requirements:

1. Provide electric strikes designed for use with type of locks shown at each opening.
2. Provide electric strikes UL Listed as burglary resistant that are tested to a minimum endurance test of 1,000,000 cycles.
3. Where required, provide electric strikes UL Listed for fire doors and frames.
4. Provide transformers and rectifiers for each strike as required. Verify voltage with electrical contractor.

## 2.11 MAGNETIC LOCKS

### A. Manufacturers:

1. Scheduled Manufacturer:
  - a. Schlage
2. Acceptable Manufacturers:
  - a. Securitron
  - b. Security Door Controls
  - c. Or equal approved by Professional

### B. Requirements:

1. Provide magnetic locks certified to meet ANSI/BHMA A156.23 classification criteria, UL10C, and UL1034 for burglary-resistant electronic locking mechanisms.

2. Provide magnetic locks equipped with SPDT Magnetic Bond Sensing device, where specified, to monitor whether enough magnetic holding force exists to ensure adequate locking and SPDT Door Status Monitor device, where specified, to monitor whether door is open or closed. Provide bond sensors fully concealed within electromagnet to resist tampering or damage.
3. Provide fasteners, mounting brackets, and spacer bars required for mounting and details.
4. Provide power supply recommended and approved by manufacturer of magnetic locks.
5. Where magnetic locks are scheduled, provide complete assemblies of controls, switches, power supplies, relays, and parts/material recommended and approved by manufacturer of magnetic locks for each individual leaf. Switches control both doors simultaneously at pairs. Locate controls as directed by Architect.

## 2.12 PUSHBUTTONS

### A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
  - a. Schlage 620/631 Series
2. Acceptable Manufacturers and Products:
  - a. No Substitute

### B. Requirements:

1. Provide push buttons as specified in hardware groups.

## 2.13 POWER SUPPLIES

### A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
  - a. Schlage/Von Duprin PS900 Series
2. Acceptable Manufacturers and Products:
  - a. Sargent 3500 series
  - b. Securitron BPS series
  - c. Or equal approved by Professional

### B. Requirements:

1. Provide power supplies approved by manufacturer of supplied electrified hardware.
2. Provide appropriate quantity of power supplies necessary for proper operation of electrified locking components as recommended by manufacturer of electrified locking components with consideration for each electrified component using power supply, location of power supply, and approved wiring diagrams. Locate power supplies as directed by Architect.
3. Provide regulated and filtered 24 VDC power supply, and UL class 2 listed.
4. Provide power supplies with the following features:

- a. 12/24 VDC Output, field selectable.
- b. Class 2 Rated power limited output.
- c. Universal 120-240 VAC input.
- d. Low voltage DC, regulated and filtered.
- e. Polarized connector for distribution boards.
- f. Fused primary input.
- g. AC input and DC output monitoring circuit w/LED indicators.
- h. Cover mounted AC Input indication.
- i. Tested and certified to meet UL294.
- j. NEMA 1 enclosure.
- k. Hinged cover w/lock down screws.
- l. High voltage protective cover.

## 2.14 CYLINDERS

### A. Manufacturers:

#### 1. Scheduled Manufacturer and Product:

- a. Best Lock Company

#### 2. Acceptable Manufacturers and Products:

- a. No Substitute
- b. The above item has been approved by the Department as a Proprietary Item. No other item will be accepted. Article 9, Paragraph 9.6, Substitution of Materials, of the General Conditions to the Construction Contract does not apply to the above item.

### B. Requirements:

- 1. Provide cylinders/cores to match Owner's existing key system, compliant with ANSI/BHMA A156.5; latest revision; cylinder face finished to match lockset, manufacturer's series as indicated. Refer to "KEYING" article, herein.

## 2.15 KEYING

### A. Scheduled System:

#### 1. Existing factory registered system:

- a. Provide cylinders/cores keyed into Owner's existing factory registered keying system. Comply with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.

### B. Requirements:

#### 1. Construction Keying:

- a. Replaceable Construction Cores.
  - 1) Provide temporary construction cores replaceable by permanent cores, furnished in accordance with the following requirements.
    - a) 3 construction control keys
    - b) 12 construction change (day) keys.

- 2) Owner or Owner's Representative will replace temporary construction cores with permanent cores.
2. Permanent Keying:
- a. Provide permanent cylinders/cores keyed by the manufacturer according to the following key system.
    - 1) Master Keying system as directed by the Owner.
  - b. Forward biting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements will be cause for replacement of cylinders/cores involved at no additional cost to Owner.
  - c. Provide keys with the following features:
    - 1) Material: Nickel silver; minimum thickness of .107-inch (2.3mm)
    - 2) Patent Protection: Keys and blanks protected by one or more utility patent(s).
  - d. Identification:
    - 1) Mark permanent cylinders/cores and keys with applicable blind code for identification. Do not provide blind code marks with actual key cuts.
    - 2) Identification stamping provisions must be approved by the Architect and Owner.
    - 3) Stamp cylinders/cores and keys with Owner's unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with "DO NOT DUPLICATE" along with the "PATENTED" or patent number to enforce the patent protection.
    - 4) Failure to comply with stamping requirements will be cause for replacement of keys involved at no additional cost to Owner.
    - 5) Forward permanent cylinders/cores to Owner, separately from keys, by means as directed by Owner.
  - e. Quantity: Furnish in the following quantities.
    - 1) Change (Day) Keys: 3 per cylinder/core.
    - 2) Permanent Control Keys: 3.
    - 3) Master Keys: 6.

## 2.16 KEY CONTROL SYSTEM

### A. Manufacturers:

1. Scheduled Manufacturer:
  - a. Telkee
2. Acceptable Manufacturers:
  - a. HPC
  - b. Lund
  - c. Or equal approved by Professional

### B. Requirements:

1. Provide key control system, including envelopes, labels, tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by system manufacturer, with capacity for 150% of number of locks required for Project.



- a. Provide complete cross index system set up by hardware supplier, and place keys on markers and hooks in cabinet as determined by final key schedule.
- b. Provide hinged-panel type cabinet for wall mounting.

## 2.17 DOOR CLOSERS

### A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
  - a. LCN 4050A series
2. Acceptable Manufacturers and Products:
  - a. Falcon SC70A series
  - b. Sargent 351 series
  - c. Or equal approved by Professional

### B. Requirements:

1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. ISO 9000 certify closers. Stamp units with date of manufacture code.
2. Provide door closers with fully hydraulic, full rack and pinion action with cast aluminum cylinder.
3. Closer Body: 1-1/2-inch (38 mm) diameter with 11/16-inch (17 mm) diameter heat-treated pinion journal and full complement bearings.
4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and all weather requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and back check.
7. Pressure Relief Valve (PRV) Technology: Not permitted.
8. Provide stick on templates, special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

## 2.18 ELECTRO-HYDRAULIC AUTOMATIC OPERATORS

### A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:
  - a. LCN 4600 series
2. Acceptable Manufacturers and Products:
  - a. Norton 6000 series
  - b. Besam Power Swing
  - c. Or equal approved by Professional

B. Requirements:

1. Provide low energy automatic operator units with hydraulic closer complying with ANSI/BHMA A156.19.
2. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
3. Provide units with conventional door closer opening and closing forces unless power operator motor is activated. Provide door closer assembly with adjustable spring size, back-check, and opening and closing speed adjustment valves to control door
4. Provide units with on/off switch for manual operation, motor start up delay, vestibule interface delay, electric lock delay, and door hold open delay.
5. Provide drop plates, brackets, and adapters for arms as required for details.
6. Provide actuator switches and receivers for operation as specified.
7. Provide weather-resistant actuators at exterior applications.
8. Provide key switches with LED's, recommended and approved by manufacturer of automatic operator as required for function described in operation description of hardware group below. Cylinders: Refer to "KEYING" article, herein.
9. Provide complete assemblies of controls, switches, power supplies, relays, and parts/material recommended and approved by manufacturer of automatic operator for each individual leaf. Actuators control both doors simultaneously at pairs. Sequence operation of exterior and vestibule doors with automatic operators to allow ingress or egress through both sets of openings as directed by Architect. Locate actuators, key switches, and other controls as directed by Architect.
10. Provide units with vestibule inputs that allow sequencing operation of two units, and SPDT relay for interfacing with latching or locking devices.

2.19 DOOR TRIM

A. Manufacturers:

1. Scheduled Manufacturer:
  - a. Ives
2. Acceptable Manufacturers:
  - a. Burns
  - b. Rockwood
  - c. Or equal approved by Professional

B. Requirements:

1. Provide push plates, push bars, pull plates, pulls, and hands-free reversible door pulls with diameter and length as scheduled.

2.20 PROTECTION PLATES

A. Manufacturers:

1. Scheduled Manufacturer:
  - a. Ives

2. Acceptable Manufacturers:
  - a. Trimco
  - b. Rockwood
  - c. Or equal approved by Professional

B. Requirements:

1. Provide protection plates with a minimum of 0.050 inch (1 mm) thick, beveled four edges as scheduled. Furnish with sheet metal or wood screws, finished to match plates.
2. Size plates 2 inches (51 mm) less width of door on single doors, pairs of doors with a mullion, and doors with edge guards. Size plates 1 inch (25 mm) less width of door on pairs without a mullion or edge guards.
3. At fire rated doors, provide protection plates over 16 inches high with UL label.

## 2.21 OVERHEAD STOPS AND OVERHEAD STOP/HOLDERS

A. Manufacturers:

1. Scheduled Manufacturers:
  - a. Glynn-Johnson
2. Acceptable Manufacturers:
  - a. Rixson
  - b. Sargent
  - c. Or equal approved by Professional

B. Requirements:

1. Provide overhead stop at any door where conditions do not allow for a wall stop or floor stop presents tripping hazard.
2. Provide friction type at doors without closer and positive type at doors with closer.

## 2.22 DOOR STOPS AND HOLDERS

A. Manufacturers:

1. Scheduled Manufacturer:
  - a. Ives
2. Acceptable Manufacturers:
  - a. Burns
  - b. Rockwood
  - c. Or equal approved by Professional

B. Provide door stops at each door leaf:

1. Provide wall stops wherever possible. Provide concave type where lockset has a push button of thumbturn.

2. Where a wall stop cannot be used, provide universal floor stops.
3. Where wall or floor stop cannot be used, provide overhead stop.
4. Provide roller bumper where doors open into each other and overhead stop cannot be used.

## 2.23 THRESHOLDS, SEALS, DOOR SWEEPS, AUTOMATIC DOOR BOTTOMS, AND GASKETING

### A. Manufacturers:

1. Scheduled Manufacturer:
  - a. Zero International
2. Acceptable Manufacturers:
  - a. National Guard
  - b. Reese
  - c. Or equal approved by professional

### B. Requirements:

1. Provide thresholds, weather-stripping, and gasketing systems as specified and per architectural details. Match finish of other items.
2. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
3. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.
4. Size thresholds 1/2 inch (13 mm) high by 5 inches (127 mm) wide by door width unless otherwise specified in the hardware sets or detailed in the drawings.

## 2.24 SILENCERS

### A. Manufacturers:

1. Scheduled Manufacturer:
  - a. Ives
2. Acceptable Manufacturers:
  - a. Rockwood
  - b. Trimco
  - c. Or equal approved by Professional

### B. Requirements:

1. Provide "push-in" type silencers for hollow metal or wood frames.
2. Provide one silencer per 30 inches (762 mm) of height on each single frame, and two for each pair frame.
3. Omit where gasketing is specified.

## 2.25 MAGNETIC HOLDERS

### A. Manufacturers:

1. Scheduled Manufacturer:
  - a. LCN
2. Acceptable Manufacturers:
  - a. Rixson
  - b. Sargent
  - c. Or equal approved by Professional

### B. Requirements:

1. Provide wall or floor mounted electromagnetic door release as specified with minimum of 25 pounds of holding force. Coordinate projection of holder and armature with other hardware and wall conditions to ensure that door sits parallel to wall when fully open. Connect magnetic holders on fire-rated doors into the fire control panel for fail-safe operation.

## 2.26 DOOR POSITION SWITCHES

### A. Manufacturers:

1. Scheduled Manufacturer:
  - a. Schlage
2. Acceptable Manufacturers:
  - a. GE-Interlogix
  - b. Sargent
  - c. Or equal approved by Professional

### B. Requirements:

1. Provide recessed or surface mounted type door position switches as specified.
2. Coordinate door and frame preparations with door and frame suppliers. If switches are being used with magnetic locking device, provide minimum of 4 inches (102 mm) between switch and magnetic locking device.

## 2.27 FINISHES

### A. FINISH: BHMA 626/652 (US26D); EXCEPT:

1. Aluminum Geared Continuous Hinges: BHMA 628 (US28)
2. Push Plates, Pulls, and Push Bars: BHMA 630 (US32D)
3. Protection Plates: BHMA 630 (US32D)
4. Overhead Stops and Holders: BHMA 630 (US32D)
5. Door Closers: Powder Coat to Match
6. Wall Stops: BHMA 630 (US32D)

7. Weatherstripping: Clear Anodized Aluminum
8. Thresholds: Mill Finish Aluminum

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance. Verify doors, frames, and walls have been properly reinforced for hardware installation.
- B. Field verify existing doors and frames receiving new hardware and existing conditions receiving new openings. Verify that new hardware is compatible with existing door and frame preparation and existing conditions.
- C. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- D. Submit a list of deficiencies in writing and proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION

- A. Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.
  1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
  2. Custom Steel Doors and Frames: HMMA 831.
  3. Interior Architectural Wood Flush Doors: ANSI/WDMA I.S. 1A
  4. Installation Guide for Doors and Hardware: DHI TDH-007-20
- B. Install door hardware in accordance with NFPA 80, NFPA 101 and provide post-install inspection, testing as specified in section 1.03.E unless otherwise required to comply with governing regulations.
- C. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.
- D. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.
- E. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.
- F. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- G. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.
- H. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated.
- I. Lock Cylinders:
  1. Install construction cores to secure building and areas during construction period.
  2. Replace construction cores with permanent cores as indicated in keying section.
  3. Furnish permanent cores to Owner for installation.
- J. Wiring: Coordinate with Division 26, ELECTRICAL and Division 28 ELECTRONIC SAFETY AND SECURITY sections for:

1. Conduit, junction boxes and wire pulls.
  2. Connections to and from power supplies to electrified hardware.
  3. Connections to fire/smoke alarm system and smoke evacuation system.
  4. Connection of wire to door position switches and wire runs to central room or area, as directed by Architect.
  5. Connections to panel interface modules, controllers, and gateways.
  6. Testing and labeling wires with Architect's opening number.
- K. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.
- L. Door Closers: Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Mount closers so they are not visible in corridors, lobbies and other public spaces unless approved by Architect.
- M. Closer/holders: Mount closer/holders on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.
- N. Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings or in equipment room, or alternate location as directed by Architect.
- O. Thresholds: Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."
- P. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they may impede traffic or present tripping hazard.
- Q. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
- R. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- S. Door Bottoms and Sweeps: Apply to bottom of door, forming seal with threshold when door is closed.

### 3.03 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
1. Spring Hinges: Adjust to achieve positive latching when door can close freely from an open position of 30 degrees.
  2. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
  3. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
- B. Occupancy Adjustment: Approximately three to six months after date of Substantial Completion, examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors and door hardware.

### 3.04 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items per manufacturer's instructions to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.05 DOOR HARDWARE SCHEDULE

- A. The intent of the hardware specification is to specify the hardware for interior and exterior doors, and to establish a type, continuity, and standard of quality. However, it is the door hardware supplier's responsibility to thoroughly review existing conditions, schedules, specifications, drawings, and other Contract Documents to verify the suitability of the hardware specified.
- B. Discrepancies, conflicting hardware, and missing items are to be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application.
- C. Hardware items are referenced in the following hardware schedule. Refer to the above specifications for special features, options, cylinders/keying, and other requirements.
- D. Hardware Sets:

Hardware Group No. 01

1	EA	CONT. HINGE	224HD	628	IVE
1	EA	PASSAGE SET	L9010 06B	626	SCH
1	EA	OH STOP	90S	652	GLY
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS	630	IVE
1	EA	KICK PLATE	8400 4" X 1" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 02

2	EA	CONT. HINGE	224HD	628	IVE
1	EA	CONST LATCHING BOLT	FB61T	630	IVE
1	EA	PASSAGE SET	L9010 06B	626	SCH
1	EA	OH STOP	90S	652	GLY
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
2	EA	KICK PLATE	8400 4" X 1" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	ASTRAGAL	8193AA	AA	ZER

Hardware Group No. 03

1	EA	BARN DOOR TRACK	2610SC	AL	JOH
1	EA	PRIVACY SET	9100BDL-5 7200P-ADA TURN	626	ACC



Hardware Group No. 04

1	EA	CONT. HINGE	224HD		628	IVE
1	EA	FIRE EXIT HARDWARE	F-25-R-L-BE-DANE		626	FAL
1	EA	MAGNETIC LOCK	M490 12/24 VDC	↗	628	SCE
1	EA	SURFACE CLOSER	4050A SCUSH		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	KICK PLATE	8400 4" X 1" LDW B-CS		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER
1	EA	PUSH BUTTON	623GR DA 12/24 VDC	↗	630	SCE
1	EA	DOOR CONTACT	679-05HM	↗	BLK	SCE
1	EA	POWER SUPPLY	PS902 BBK FA900 120/240 VAC	↗	LGR	SCE
1			CARD READER - WORK OF DIVISION 28			
1	EA	NOTE	PROVIDE POINT TO POINT WIRING DIAGRAMS			
1	EA	NOTE	PROVIDE RISER WIRING DIAGRAMS			

DOOR NORMALLY CLOSED AND LOCKED VIA MAGLOCK.  
PRESENTATION OF VALID CREDENTIAL TO CARD READER TO ALLOW EGRESS.  
MAGLOCK TO BE TIED INTO FIRE ALARM SYSTEM AND BECOME DISENGAGED UNDER ALARM  
CONDITIONS.  
PUSHBUTTON LOCATED IN STAIR TO DISENGAGE MAGLOCK AND ALLOW ENTRY VIA LEVER  
TRIM.

Hardware Group No. 05

3	EA	HINGE	5BB1 4.5 X 4.5		652	IVE
1	EA	STOREROOM LOCK	L9080HD 06A		626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED		626	BES
1	EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC	↗	630	VON
1	EA	SURFACE CLOSER	4050A EDA		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CVX		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER
1			CARD READER - WORK OF DIVISION 28			
1	EA	NOTE	PROVIDE POINT TO POINT WIRING DIAGRAMS			
1	EA	NOTE	PROVIDE RISER WIRING DIAGRAMS			

Hardware Group No. 06

1	EA	CONT. HINGE	224HD EPT		628	IVE
1	EA	POWER TRANSFER	EPT10 CON	↗	689	VON
1	EA	ELEC PANIC HARDWARE	MEL-25-R-NL-OP 24 VDC	↗	626	FAL
1	EA	MAGNETIC LOCK	M490 12/24 VDC	↗	628	SCE
1	EA	90 DEG OFFSET PULL	8190EZHD 12" STD		630- 316	IVE
1	EA	SURFACE CLOSER	4050A SCUSH		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	DOOR SWEEP	39A		A	ZER
1	EA	THRESHOLD	655A		A	ZER
2	EA	WIRE HARNESS	CON-192P	↗		SCH
1	EA	DOOR CONTACT	679-05HM	↗	BLK	SCE
1	EA	POWER SUPPLY	PS904 BBK 900-4RL-FA 120/240 VAC	↗	LGR	SCE
2			CARD READER - WORK OF DIVISION 28			
1	EA	NOTE	PROVIDE POINT TO POINT WIRING DIAGRAMS			
1	EA	NOTE	PROVIDE RISER WIRING DIAGRAMS			

DOOR NORMALLY CLOSED AND LOCKED VIA MAGLOCK.

PRESENTATION OF VALID CREDENTIAL TO INTERIOR CARD READER TO RELEASE MAGLOCK AND ALLOW EGRESS.

PUSH BUTTON TO EGRESS.

PRESENTATION OF VALID CREDENTIAL TO EXTERIOR CARD READER TO RELEASE MAGLOCK, RETRACT LATCHBOLT AND ALLOW ENTRY.

MAGLOCK TO BE TIED INTO FIRE ALARM SYSTEM AND BECOME DISENGAGED UNDER ALARM CONDITIONS.

Hardware Group No. 07

1	EA	CONT. HINGE	112HD EPT		628	IVE
1	EA	POWER TRANSFER	EPT10 CON	↗	689	VON
1	EA	ELEC PANIC HARDWARE	MEL-24-R-NL-OP 24 VDC	↗	626	FAL
1	EA	MAGNETIC LOCK	M490 12/24 VDC	↗	628	SCE
1	EA	90 DEG OFFSET PULL	8190EZHD 12" STD		630- 316	IVE
1	EA	OH STOP	100S		652	GLY
1	EA	SURFACE CLOSER	4050A EDA		689	LCN
1	EA	PA MOUNTING PLATE	4050A-18PA SRT		689	LCN
1	EA	BLADE STOP SPACER	4050A-61 SRT		689	LCN
1	EA	DOOR SWEEP	39A		A	ZER
1	EA	THRESHOLD	655A		A	ZER
2	EA	WIRE HARNESS	CON-192P	↗		SCH
1	EA	DOOR CONTACT	679-05HM	↗	BLK	SCE
1	EA	POWER SUPPLY	PS904 BBK 900-4RL-FA 120/240 VAC	↗	LGR	SCE
2			CARD READER - WORK OF DIVISION 28			
1	EA	NOTE	PROVIDE POINT TO POINT WIRING DIAGRAMS			
1	EA	NOTE	PROVIDE RISER WIRING DIAGRAMS			

DOOR NORMALLY CLOSED AND LOCKED VIA MAGLOCK.  
PRESENTATION OF VALID CREDENTIAL TO INTERIOR CARD READER TO RELEASE MAGLOCK  
AND ALLOW EGRESS.  
PUSH BUTTON TO EGRESS  
PRESENTATION OF VALID CREDENTIAL TO EXTERIOR CARD READER TO RELEASE MAGLOCK,  
RETRACT LATCHBOLT AND ALLOW ENTRY.  
MAGLOCK TO BE TIED INTO FIRE ALARM SYSTEM AND BECOME DISENGAGED UNDER ALARM  
CONDITIONS.

Hardware Group No. 08

1	EA	CONT. HINGE	112HD EPT		628	IVE
1	EA	POWER TRANSFER	EPT10 CON	↗	689	VON
1	EA	ELEC PANIC HARDWARE	MEL-24-R-NL-OP 24 VDC	↗	626	FAL
1	EA	MAGNETIC LOCK	M490 12/24 VDC	↗	628	SCE
1	EA	90 DEG OFFSET PULL	8190EZHD 12" STD		630- 316	IVE
1	EA	OH STOP	100S		652	GLY
1	EA	SURF. AUTO OPERATOR	4642 WMS 120 VAC	↗	689	LCN
2	EA	ACTUATOR PKG	8310-3857T	↗	630	LCN
2	EA	SENSOR	8310-878	↗		LCN
1	EA	DOOR SWEEP	39A		A	ZER
1	EA	THRESHOLD	655A		A	ZER
2	EA	WIRE HARNESS	CON-192P	↗		SCH
1	EA	DOOR CONTACT	679-05HM	↗	BLK	SCE
1	EA	POWER SUPPLY	PS904 BBK 900-4RL-FA 120/240 VAC	↗	LGR	SCE
2			CARD READER - WORK OF DIVISION 28			
1	EA	NOTE	PROVIDE POINT TO POINT WIRING DIAGRAMS			
1	EA	NOTE	PROVIDE RISER WIRING DIAGRAMS			

DOOR NORMALLY CLOSED AND LOCKED VIA MAGLOCK.

PRESENTATION OF VALID CREDENTIAL TO INTERIOR CARD READER TO RELEASE MAGLOCK AND ALLOW EGRESS.

PRESENTATION OF VALID CREDENTIAL TO EXTERIOR CARD READER TO RELEASE MAGLOCK, RETRACT LATCHBOLT AND ALLOW ENTRY.

MAGLOCK TO BE TIED INTO FIRE ALARM SYSTEM AND BECOME DISENGAGED UNDER ALARM CONDITIONS.

WHEN LATCHBOLT IS ELECTRICALLY RETRACTED, AUTOMATIC OPERATOR ACTUATOR BECOME ACTIVE. DEPRESSING EITHER ACTUATOR WHEN ACTIVE WILL OPEN DOOR AUTOMATICALLY.

Hardware Group No. 09

1	EA	CONT. HINGE	112HD EPT		628	IVE
1	EA	POWER TRANSFER	EPT10 CON	↗	689	VON
1	EA	ELEC PANIC HARDWARE	MEL-24-R-NL-OP 24 VDC	↗	626	FAL
1	EA	90 DEG OFFSET PULL	8190EZHD 12" STD		630- 316	IVE
1	EA	OH STOP	100S		652	GLY
1	EA	SURF. AUTO OPERATOR	4642 WMS 120 VAC	↗	689	LCN
2	EA	SENSOR	8310-3881	↗		LCN
1	EA	SAFETY RAILS	AS REQUIRED			
1	EA	DOOR SWEEP	39A		A	ZER
1	EA	THRESHOLD	655A		A	ZER
2	EA	WIRE HARNESS	CON-192P	↗		SCH
1	EA	DOOR CONTACT	679-05HM	↗	BLK	SCE
1	EA	POWER SUPPLY	PS904 BBK 900-4RL-FA 120/240 VAC	↗	LGR	SCE
2			CARD READER - WORK OF DIVISION 28			
1	EA	NOTE	PROVIDE POINT TO POINT WIRING DIAGRAMS			
1	EA	NOTE	PROVIDE RISER WIRING DIAGRAMS			

DOOR NORMALLY CLOSED AND LOCKED AND SENSORS TURNED OFF. ENTRY BY PRESENTATION OF VALID CREDENTIAL. WITH VALID CREDENTIAL OR WHEN DOOR IS ELECTRONICALLY DOGGED ACTUATOR SENSORS ARE ACTIVE AND WILL OPEN DOOR. PRESENTATION OF VALID CREDENTIAL TO INTERIOR CARD READER TO RELEASE MAGLOCK AND ALLOW EGRESS. PRESENTATION OF VALID CREDENTIAL TO EXTERIOR CARD READER TO RELEASE MAGLOCK, RETRACT LATCHBOLT AND ALLOW ENTRY. MAGLOCK TO BE TIED INTO FIRE ALARM SYSTEM AND BECOME DISENGAGED UNDER ALARM CONDITIONS. WHEN LATCHBOLT IS ELECTRICALLY RETRACTED, AUTOMATIC OPERATOR ACTUATOR BECOME ACTIVE. DEPRESSING EITHER ACTUATOR WHEN ACTIVE WILL OPEN DOOR AUTOMATICALLY.

Hardware Group No. 10

1	EA	CONT. HINGE	224HD		628	IVE
1	EA	PANIC HARDWARE	LD-25-R-EO		626	FAL
1	EA	MAGNETIC LOCK	M490 12/24 VDC	↗	628	SCE
1	EA	SURFACE CLOSER	4050A SCUSH		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	DOOR SWEEP	39A		A	ZER
1	EA	THRESHOLD	655A		A	ZER
1	EA	DOOR CONTACT	679-05HM	↗	BLK	SCE
1	EA	POWER SUPPLY	PS902 BBK FA900 120/240 VAC	↗	LGR	SCE
1			CARD READER - WORK OF DIVISION 28			
1	EA	NOTE	PROVIDE POINT TO POINT WIRING DIAGRAMS			
1	EA	NOTE	PROVIDE RISER WIRING DIAGRAMS			

DOOR NORMALLY CLOSED AND LOCKED VIA MAGLOCK.  
PRESENTATION OF VALID CREDENTIAL TO CARD READER TO ALLOW EGRESS.  
PUSH BUTTON TO EGRESS.  
MAGLOCK TO BE TIED INTO FIRE ALARM SYSTEM AND BECOME DISENGAGED UNDER ALARM  
CONDITIONS.

Hardware Group No. 11

2	EA	CONT. HINGE	224XY EPT		628	IVE
2	EA	POWER TRANSFER	EPT10 CON	✓	689	VON
2	EA	ELEC FIRE EXIT HARDWARE	LMRX-MEL-F-25-V-EO-LBRAFL 24 VDC	✓	626	FAL
1	EA	MAGNETIC LOCK	M490 12/24 VDC	✓	628	SCE
2	EA	SURF. AUTO OPERATOR	4642 WMS 120 VAC	✓	689	LCN
2	EA	ACTUATOR PKG	8310-3857T	✓	630	LCN
2	EA	SENSOR	8310-879	✓		LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS		630	IVE
2	EA	KICK PLATE	8400 4" X 1" LDW B-CS		630	IVE
2	EA	MAGNET	SEM7850 12V/24V/120V	✓	689	LCN
1	EA	GASKETING	488SBK PSA		BK	ZER
2	EA	ASTRAGAL	8193AA		AA	ZER
4	EA	WIRE HARNESS	CON-192P	✓		SCH
2	EA	DOOR CONTACT	679-05HM	✓	BLK	SCE
1	EA	POWER SUPPLY	PS902 BBK FA900 120/240 VAC	✓	LGR	SCE
1			CARD READER - WORK OF DIVISION 28			
1	EA	NOTE	PROVIDE POINT TO POINT WIRING DIAGRAMS			
1	EA	NOTE	PROVIDE RISER WIRING DIAGRAMS			

DOOR NORMALLY CLOSED AND LOCKED.

MAGLOCK TO BE INSTALLED ON DOOR SWINGING INTO RESIDENT POD.

PRESENTATION OF VALID CREDENTIAL TO RELEASE MAGLOCK AND RETRACT LATCHBOLTS AND ALLOW ENTRY, EITHER MANUALLY OR BY DEPRESSING OUTSIDE ACTUATOR WHICH WILL OPEN DOORS VIA AUTOMATIC OPERATOR.

Hardware Group No. 12

2	EA	CONT. HINGE	224XY EPT		628	IVE
2	EA	POWER TRANSFER	EPT10 CON	↗	689	VON
2	EA	ELEC FIRE EXIT HARDWARE	LMRX-MEL-F-25-V-L-BE- LBRAFL-DANE 24 VDC	↗	626	FAL
2	EA	SURF. AUTO OPERATOR	4642 WMS 120 VAC	↗	689	LCN
2	EA	ACTUATOR PKG	8310-3857T	↗	630	LCN
2	EA	SENSOR	8310-879	↗		LCN
2	EA	KICK PLATE	8400 34" X 1" LDW B-CS		630	IVE
2	EA	KICK PLATE	8400 4" X 1" LDW B-CS		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER
2	EA	ASTRAGAL	8193AA		AA	ZER
2	EA	WIRE HARNESS	CON-192P	↗		SCH
1	EA	POWER SUPPLY	PS902 BBK 900-2RS FA900 120/240 VAC	↗	LGR	SCE
1	EA	NOTE	PROVIDE POINT TO POINT WIRING DIAGRAMS			
1	EA	NOTE	PROVIDE RISER WIRING DIAGRAMS			

DOOR NORMALLY CLOSED AND UNLOCKED.

ENTRY MANUALLY OR BY DEPRESSING ACTUATOR WHICH WILL OPEN DOORS VIA AUTOMATIC OPERATOR.



Hardware Group No. 13

2	EA	CONT. HINGE	224XY EPT		628	IVE
2	EA	POWER TRANSFER	EPT10 CON	↗	689	VON
2	EA	ELEC PANIC HARDWARE	LMRX-MEL-25-V-L-LBR-DANE 24 VDC	↗	626	FAL
2	EA	CYLINDER	IC CYLINDER AS REQUIRED		612	BES
2	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED		626	BES
2	EA	SURF. AUTO OPERATOR	4642 WMS 120 VAC	↗	689	LCN
2	EA	ACTUATOR PKG	8310-3857T	↗	630	LCN
2	EA	SENSOR	8310-879	↗		LCN
2	EA	KICK PLATE	8400 34" X 1" LDW B-CS		630	IVE
2	EA	KICK PLATE	8400 4" X 1" LDW B-CS		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER
2	EA	ASTRAGAL	8193AA		AA	ZER
4	EA	WIRE HARNESS	CON-192P	↗		SCH
1	EA	POWER SUPPLY	PS902 BBK 900-2RS FA900 120/240 VAC	↗	LGR	SCE
1	EA	NOTE	PROVIDE POINT TO POINT WIRING DIAGRAMS			
1	EA	NOTE	PROVIDE RISER WIRING DIAGRAMS			

DOOR NORMALLY CLOSED AND UNLOCKED.

ENTRY MANUALLY OR BY DEPRESSING ACTUATOR WHICH WILL OPEN DOORS VIA AUTOMATIC OPERATOR.

WHEN DOORS ARE LOCKED , AUTOMATIC OPERATOR TO BE TURNED OFF.

Hardware Group No. 14

1	EA	CONT. HINGE	224HD		628	IVE
1	EA	INSTITUTION LOCK	L9082HD 06A		626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED		626	BES
1	EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC	↗	630	VON
1	EA	SURFACE CLOSER	4050A RW/PA		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER
2			CARD READER - WORK OF DIVISION 28			
1	EA	NOTE	PROVIDE POINT TO POINT WIRING DIAGRAMS			
1	EA	NOTE	PROVIDE RISER WIRING DIAGRAMS			

Hardware Group No. 15

1	EA	CONT. HINGE	224HD EPT		628	IVE
1	EA	POWER TRANSFER	EPT10 CON	↗	689	VON
1	EA	EU MORTISE LOCK	L9095HDEU 06A 10-144 CON 12/24 VDC	↗	626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED		626	BES
1	EA	OH STOP	100S		652	GLY
1	EA	SURFACE CLOSER	4050A RW/PA ST-5003		689	LCN
1	EA	MOUNTING PLATE	4050A-18 SRT		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER
2	EA	WIRE HARNESS	CON-192P	↗		SCH
1			CARD READER - WORK OF DIVISION 28			
1	EA	NOTE	PROVIDE POINT TO POINT WIRING DIAGRAMS			
1	EA	NOTE	PROVIDE RISER WIRING DIAGRAMS			

Hardware Group No. 16

1	EA	CONT. HINGE	224HD EPT		628	IVE
1	EA	POWER TRANSFER	EPT10 CON	↗	689	VON
1	EA	EU MORTISE LOCK	L9095HDEU 06A 10-144 CON 12/24 VDC	↗	626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED		626	BES
1	EA	SURFACE CLOSER	4050A EDA		689	LCN
1	EA	MAGNET	SEM7820 12V/24V/120V	↗	689	LCN
1	EA	GASKETING	488SBK PSA		BK	ZER
2	EA	WIRE HARNESS	CON-192P	↗		SCH
2			CARD READER - WORK OF DIVISION 28			
1	EA	NOTE	PROVIDE POINT TO POINT WIRING DIAGRAMS			
1	EA	NOTE	PROVIDE RISER WIRING DIAGRAMS			

Hardware Group No. 17

3	EA	HINGE	5BB1 4.5 X 4.5		652	IVE
1	EA	STOREROOM LOCK	L9080HD 06A		626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED		626	BES
1	EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC	↗	630	VON
1	EA	SURFACE CLOSER	4050A RW/PA		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CVX		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER
1			CARD READER - WORK OF DIVISION 28			
	EA	NOTE	PROVIDE POINT TO POINT WIRING DIAGRAMS			
	EA	NOTE	PROVIDE RISER WIRING DIAGRAMS			

Hardware Group No. 18

3	EA	HINGE	5BB1 4.5 X 4.5		652	IVE
1	EA	STOREROOM LOCK	L9080HD 06A		626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED		626	BES
1	EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC	↗	630	VON
1	EA	OH STOP	100S		652	GLY
1	EA	SURFACE CLOSER	4050A RW/PA ST-5003		689	LCN
1	EA	MOUNTING PLATE	4050A-18 SRT		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER
1			CARD READER - WORK OF DIVISION 28			
	EA	NOTE	PROVIDE POINT TO POINT WIRING DIAGRAMS			
	EA	NOTE	PROVIDE RISER WIRING DIAGRAMS			

Hardware Group No. 19

1	EA	CONT. HINGE	224HD EPT		628	IVE
1	EA	POWER TRANSFER	EPT10	↗	689	VON
1	EA	DUMMY PUSH BAR	250DT		626	FAL
1	EA	MAGNETIC LOCK	M490 TJ490 12/24 VDC	↗	628	SCE
1	EA	90 DEG OFFSET PULL	8190EZHD 12" STD		630- 316	IVE
1	EA	SURF. AUTO OPERATOR	4631 WMS 120 VAC	↗	689	LCN
2	EA	ACTUATOR PKG	8310-3857T	↗	630	LCN
2	EA	SENSOR	8310-878	↗		LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	DOOR SWEEP	39A		A	ZER
1	EA	THRESHOLD	655A		A	ZER
1	EA	DOOR CONTACT	679-05HM	↗	BLK	SCE
1	EA	POWER SUPPLY	PS904 BBK 900-4RL-FA 120/240 VAC	↗	LGR	SCE
2			CARD READER - WORK OF DIVISION 28			
1	EA	NOTE	PROVIDE POINT TO POINT WIRING DIAGRAMS			
1	EA	NOTE	PROVIDE RISER WIRING DIAGRAMS			

DOOR NORMALLY CLOSED AND LOCKED VIA MAGLOCK.  
PRESENTATION OF VALID CREDENTIAL TO INTERIOR CARD READER TO RELEASE MAGLOCK  
AND ALLOW ENTRY INTO COURTYARD.  
PRESENTATION OF VALID CREDENTIAL TO EXTERIOR CARD READER TO RELEASE MAGLOCK,  
AND ALLOW ENTRY INTO BUILDING.  
MAGLOCK TO BE TIED INTO FIRE ALARM SYSTEM AND BECOME DISENGAGED UNDER ALARM  
CONDITIONS.  
WHEN MAGLOCK IS RELEASED, PRESSING EITHER ACTUATOR WILL AUTOMATICALLY OPEN  
DOOR.

Hardware Group No. 20

1	EA	CONT. HINGE	224HD		628	IVE
1	EA	STOREROOM LOCK	L9080HD 06A		626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED		626	BES
1	EA	SURFACE CLOSER	4050A RW/PA		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CVX		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER

Hardware Group No. 21

1	EA	CONT. HINGE	224HD	628	IVE
1	EA	STOREROOM LOCK	L9080HD 06A	626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED	626	BES
1	EA	OH STOP	100S	652	GLY
1	EA	SURFACE CLOSER	4050A RW/PA ST-5003	689	LCN
1	EA	MOUNTING PLATE	4050A-18 SRT	689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

Hardware Group No. 22

1	EA	CONT. HINGE	224HD	628	IVE
1	EA	STOREROOM LOCK	L9080HD 06A	626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED	626	BES
1	EA	OH STOP	90S	652	GLY
1	EA	SURFACE CLOSER	4050A RW/PA	689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 23

3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	L9080HD 06A	626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED	626	BES
1	EA	SURFACE CLOSER	4050A EDA	689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 24

3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	STOREROOM LOCK	L9080HD 06A	626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED	626	BES
1	EA	SURFACE CLOSER	4050A RW/PA	689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 25

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	L9080HD 06A	626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED	626	BES
1	EA	OH STOP	100S	652	GLY
1	EA	SURFACE CLOSER	4050A RW/PA ST-5003	689	LCN
1	EA	MOUNTING PLATE	4050A-18 SRT	689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 26

1	EA	CONT. HINGE	224HD	628	IVE
1	EA	CLASSROOM LOCK	L9070HD 06A	626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED	626	BES
1	EA	SURFACE CLOSER	4050A RW/PA	689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 27

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	CLASSROOM LOCK	L9070HD 06A	626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED	626	BES
1	EA	SURFACE CLOSER	4050A RW/PA	689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

Hardware Group No. 28

6	EA	HINGE	5BB1 4.5 X 4.5		652	IVE
2	EA	POWER TRANSFER	EPT10 CON	↗	689	VON
1	SET	CONST LATCHING BOLT	FB61P		630	IVE
1	EA	DUST PROOF STRIKE	DP2		626	IVE
1	EA	STOREROOM LOCK	L9080HD 06A		626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED		626	BES
1	EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC	↗	630	VON
1	EA	SURFACE CLOSER	4050A RW/PA		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CVX		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER
2	EA	WIRE HARNESS	CON-192P	↗		SCH
2	EA	DOOR CONTACT	679-05HM	↗	BLK	SCE
1			CARD READER - WORK OF DIVISION 28			
1	EA	NOTE	PROVIDE POINT TO POINT WIRING DIAGRAMS			
1	EA	NOTE	PROVIDE RISER WIRING DIAGRAMS			

Hardware Group No. 29

3	EA	HINGE	5BB1 4.5 X 4.5		652	IVE
1	EA	CLASSROOM LOCK	L9070HD 06A		626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED		626	BES
1	EA	OH STOP	100S		652	GLY
1	EA	SURFACE CLOSER	4050A RW/PA ST-5003		689	LCN
1	EA	MOUNTING PLATE	4050A-18 SRT		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER

Hardware Group No. 30

1	EA	CONT. HINGE	224HD	628	IVE
1	EA	FACULTY RESTROOM	L9485L 06A L583-363 L283-722	626	SCH
1	EA	CYLINDER	IC CYLINDER AS REQUIRED	612	BES
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED	626	BES
1	EA	SURFACE CLOSER	4050A RW/PA	689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS	630	IVE
1	EA	KICK PLATE	8400 4" X 1" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

Hardware Group No. 31

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PRIVACY W/COIN TURN	L9044 06A L583-363 L283-722	626	SCH
1	EA	SURFACE CLOSER	4050A RW/PA	689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS	630	IVE
1	EA	KICK PLATE	8400 4" X 1" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 32

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PRIVACY LOCK	L9040 06A L583-363 L283-722	626	SCH
1	EA	SURFACE CLOSER	4050A RW/PA	689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS	630	IVE
1	EA	KICK PLATE	8400 4" X 1" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 33

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PRIVACY LOCK	L9040 06A L583-363 L283-722	626	SCH
1	EA	SURFACE CLOSER	4050A EDA	689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS	630	IVE
1	EA	KICK PLATE	8400 4" X 1" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER



Hardware Group No. 34

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PRIVACY LOCK	L9040 06A L583-363 L283-722	626	SCH
1	EA	OH STOP	100S	652	GLY
1	EA	SURFACE CLOSER	4050A RW/PA ST-5003	689	LCN
1	EA	MOUNTING PLATE	4050A-18 SRT	689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS	630	IVE
1	EA	KICK PLATE	8400 4" X 1" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 35

3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	DBL CYL STORE W/DB	L9466P6 06A	626	SCH
2	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED	626	BES
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 36

3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	DBL CYL STORE W/DB	L9466P6 06A	626	SCH
2	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED	626	BES
1	EA	SURFACE CLOSER	4050A SCUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 37

1	EA	CONT. HINGE	224HD EPT		628	IVE
1	EA	POWER TRANSFER	EPT10 CON	↗	689	VON
1	EA	ELEC PANIC HARDWARE	RX-FSE-25-R-L-DANE 24 VDC	↗	626	FAL
1	EA	CYLINDER	IC CYLINDER AS REQUIRED		612	BES
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED		626	BES
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CVX		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER
2	EA	WIRE HARNESS	CON-192P	↗		SCH
1	EA	POWER SUPPLY	PS902 BBK FA900 120/240 VAC	↗	LGR	SCE
1			CARD READER - WORK OF DIVISION 28			
1	EA	NOTE	PROVIDE POINT TO POINT WIRING DIAGRAMS			
1	EA	NOTE	PROVIDE RISER WIRING DIAGRAMS			

Hardware Group No. 38

2	EA	CONT. HINGE	224HD		628	IVE
2	EA	PANIC HARDWARE	25-V-L-LBR-DANE		626	FAL
2	EA	CYLINDER	IC CYLINDER AS REQUIRED		612	BES
2	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED		626	BES
2	EA	SURFACE CLOSER	4050A HEDA		689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS		630	IVE
2	EA	WALL STOP	WS406/407CVX		630	IVE
2	EA	SILENCER	SR64		GRY	IVE

Hardware Group No. 39

1	EA	CONT. HINGE	112HD		628	IVE
1	EA	DEADLATCH	4710		628	ADA
1	EA	PULL PADDLE	4591-0X-00		626	ADA
1	EA	CYLINDER	IC CYLINDER AS REQUIRED		612	BES
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED		626	BES
1	EA	PUSH/PULL BAR	9190EZHD-12"-NO		630- 316	IVE
1	EA	SURF. AUTO OPERATOR	4631 WMS 120 VAC	↗	689	LCN
2	EA	ACTUATOR PKG	8310-3857T	↗	630	LCN
2	EA	SENSOR	8310-878	↗		LCN
1	EA	WALL STOP	WS406/407CVX		630	IVE

DOOR NORMALLY CLOSED BUT UNLOCKED WITH LATCHBOLT RETRACTED FOR PUSH/PULL OPERATION. WHEN DOOR IS UNLOCKED FOR PUSH/PULL OPERATION, AUTOMATIC OPERATOR TO BE TURNED ON AND IF EITHER ACTUATOR IS DEPRESSED THE DOOR WILL OPEN AUTOMATICALLY.

AUTOMATIC OPERATOR TO BE TURNED OFF WHEN DOOR IS LOCKED.

Hardware Group No. 40

1	EA	CONT. HINGE	224HD		628	IVE
1	EA	STOREROOM LOCK	L9080HD 06A		626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED		626	BES
1	EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC	↗	630	VON
1	EA	SURFACE CLOSER	4050A RW/PA		689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER
1			CARD READER - WORK OF DIVISION 28			
1	EA	NOTE	PROVIDE POINT TO POINT WIRING DIAGRAMS			
1	EA	NOTE	PROVIDE RISER WIRING DIAGRAMS			

Hardware Group No. 41

3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	FIRE EXIT HARDWARE	F-25-R-L-NL-DANE	626	FAL
1	EA	CYLINDER	IC CYLINDER AS REQUIRED	612	BES
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED	626	BES
1	EA	SURFACE CLOSER	4050A EDA	689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 42

2	EA	CONT. HINGE	224HD	628	IVE
2	EA	FIRE EXIT HARDWARE	F-25-V-L-NL-LBRAF-L-DANE	626	FAL
2	EA	CYLINDER	IC CYLINDER AS REQUIRED	612	BES
2	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED	626	BES
2	EA	SURFACE CLOSER	4050A EDA	689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
2	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	ASTRAGAL	8193AA	AA	ZER

Hardware Group No. 43

1	EA	CONT. HINGE	224HD	628	IVE
1	EA	CLASSROOM DEAD LOCK	L463HD XB11-720	626	SCH
1	EA	CYLINDER	IC CYLINDER AS REQUIRED	612	BES
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED	626	BES
1	EA	PUSH PLATE	8200 4" X 16"	630	IVE
1	EA	PULL PLATE	8302 10" 4" X 16"	630	IVE
1	EA	OH STOP	100S	652	GLY
1	EA	SURFACE CLOSER	4050A RW/PA ST-5003	689	LCN
1	EA	MOUNTING PLATE	4050A-18 SRT	689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS	630	IVE
1	EA	KICK PLATE	8400 4" X 1" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 44

3	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	PUSH PLATE	8200 4" X 16"	630	IVE
1	EA	PULL PLATE	8302 10" 4" X 16"	630	IVE
1	EA	OH STOP	100S	652	GLY
1	EA	SURFACE CLOSER	4050A RW/PA ST-5003	689	LCN
1	EA	MOUNTING PLATE	4050A-18 SRT	689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS	630	IVE
1	EA	KICK PLATE	8400 4" X 1" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 45

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	OFFICE/ENTRY LOCK	L9050HD 06A L583-363	626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED	626	BES
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 46

3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	OFFICE/ENTRY LOCK	L9050HD 06A L583-363	626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED	626	BES
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 47

3	EA	HINGE	5BB1 4.5 X 4.5 NRP		652	IVE
1	EA	CLASSROOM LOCK	L9070HD 06A		626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED		626	BES
1	EA	ELECTRIC STRIKE	6211 FSE DSLC 12/16/24/28 VAC/VDC	↗	630	VON
1	EA	SURF. AUTO OPERATOR	4642 WMS 120 VAC	↗	689	LCN
2	EA	ACTUATOR PKG	8310-3857T	↗	630	LCN
2	EA	SENSOR	8310-878	↗		LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS		630	IVE
1	EA	WALL STOP	WS406/407CVX		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER
1			CARD READER - WORK OF DIVISION 28			
1	EA	NOTE	PROVIDE POINT TO POINT WIRING DIAGRAMS			
1	EA	NOTE	PROVIDE RISER WIRING DIAGRAMS			

AUTOMATIC OPERATOR TO BE TURNED ON DURING BUSINESS HOURS. WHEN AUTOMATIC OPERATOR IS TURNED ON DEPRESSING EITHER ACTUATOR WILL RELEASE ELECTRIC STRIKE AND OPEN DOOR.

LOCKSET CAN BE LEFT UNLOCKED DURING BUSINESS HOURS FOR MANUAL OPERATION. FREE EGRESS AT ALL TIMES BY TURNING LEVER.

Hardware Group No. 48

1	EA	SLIDING DOOR	BALANCE OF HARDWARE BY SLIDING DOOR MANUFACTURER			
2	EA	CYLINDER	IC CYLINDER AS REQUIRED		612	BES
2	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED		626	BES

Hardware Group No. 49

6	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	CONST LATCHING BOLT	FB61T	630	IVE
1	EA	STOREROOM LOCK	L9080HD 06A	626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED	626	BES
1	EA	COORDINATOR	COR X FL	628	IVE
2	EA	MOUNTING BRACKET	MB	689	IVE
2	EA	SURFACE CLOSER	4050A CUSH	689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	ASTRAGAL	8193AA	AA	ZER

Hardware Group No. 50

2	EA	CONT. HINGE	224HD EPT	628	IVE
2	EA	POWER TRANSFER	EPT10 CON	689	VON
2	EA	ELEC FIRE EXIT HARDWARE	LMRX-MEL-F-25-V-L-NL-LBRAFL-DANE 24 VDC	626	FAL
2	EA	CYLINDER	IC CYLINDER AS REQUIRED	612	BES
2	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED	626	BES
1	EA	SURF. AUTO OPERATOR	4642 WMS 120 VAC	689	LCN
2	EA	ACTUATOR PKG	8310-3857T	630	LCN
2	EA	SENSOR	8310-879		LCN
2	EA	ARMOR PLATE	8400 36" X 1" LDW B-CS	630	IVE
2	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	ASTRAGAL	8193AA	AA	ZER
1	EA	POWER SUPPLY	PS902 BBK 900-2RS FA900 120/240 VAC	LGR	SCE
1			CARD READER - WORK OF DIVISION 28		
1	EA	NOTE	PROVIDE POINT TO POINT WIRING DIAGRAMS		
1	EA	NOTE	PROVIDE RISER WIRING DIAGRAMS		

DOOR NORMALLY CLOSED AND LOCKED. PRESENTATION OF VALID CREDENTIAL TO RETRACT LATCHBOLT AND ALLOW MANUAL ENTRY OR ALLOW EXTERIOR ACTUATOR TO BECOME ACTIVE AND IF ACTUATOR IS DEPRESSED OPEN DOOR AUTOMATICALLY. LM SWITCH TO MONITOR LATCHBOLT STATUS AND IF LATCHBOLT IS RETRACTED THE EXTERIOR ACTUATOR BECOMES OPERABLE. FREE EGRESS FROM INTERIOR AT ALL TIMES EITHER MANUALLY BY DEPRESSING EXIT DEVICE OR BY DEPRESSING ACTUATOR WHICH WILL RETRACT LATCHBOLT AND OPEN DOOR AUTOMATICALLY.

Hardware Group No. 51

6	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	CONST LATCHING BOLT	FB61T	630	IVE
1	EA	STOREROOM LOCK	L9080HD 06A	626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED	626	BES
1	EA	COORDINATOR	COR X FL	628	IVE
2	EA	MOUNTING BRACKET	MB	689	IVE
2	EA	SURFACE CLOSER	4050A SCUSH	689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	ASTRAGAL	8193AA	AA	ZER

Hardware Group No. 52

6	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	CONST LATCHING BOLT	FB61T	630	IVE
1	EA	STOREROOM LOCK	L9080HD 06A	626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED	626	BES
1	EA	ELECTRIC STRIKE	6211 FSE 12/16/24/28 VAC/VDC	630	VON
1	EA	COORDINATOR	COR X FL	628	IVE
2	EA	MOUNTING BRACKET	MB	689	IVE
2	EA	SURFACE CLOSER	4050A RW/PA	689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
2	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	ASTRAGAL	8193AA	AA	ZER
2	EA	WIRE HARNESS	CON-192P		SCH
2	EA	DOOR CONTACT	679-05HM	BLK	SCE
1	EA	MOTION SENSOR	SCANII 12/24 VDC	BLK	SCE
1			CARD READER - WORK OF DIVISION 28		
1	EA	NOTE	PROVIDE POINT TO POINT WIRING DIAGRAMS		
1	EA	NOTE	PROVIDE RISER WIRING DIAGRAMS		



Hardware Group No. 53

6	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVE
1	EA	CONST LATCHING BOLT	FB51T	630	IVE
1	EA	STOREROOM LOCK	L9080HD 06A	626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED	626	BES
1	EA	COORDINATOR	COR X FL	628	IVE
2	EA	MOUNTING BRACKET	MB	689	IVE
2	EA	SURFACE CLOSER	4050A EDA	689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
2	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	ASTRAGAL	8193AA	AA	ZER

Hardware Group No. 54

2	EA	CONT. HINGE	224HD	628	IVE
1	EA	CONST LATCHING BOLT	FB51T	630	IVE
1	EA	STOREROOM LOCK	L9080HD 06A	626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED	626	BES
1	EA	COORDINATOR	COR X FL	628	IVE
2	EA	MOUNTING BRACKET	MB	689	IVE
2	EA	OH STOP	100S	652	GLY
2	EA	SURFACE CLOSER	4050A RW/PA ST-5003	689	LCN
1	EA	MOUNTING PLATE	4050A-18 SRT	689	LCN
2	EA	ARMOR PLATE	8400 36" X 1" LDW B-CS	630	IVE
2	EA	KICK PLATE	8400 4" X 1" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	ASTRAGAL	8193AA	AA	ZER

Hardware Group No. 55

2	EA	CONT. HINGE	224HD	628	IVE
2	EA	PUSH PLATE	8200 4" X 16"	630	IVE
2	EA	PULL PLATE	8302 10" 4" X 16"	630	IVE
2	EA	SURF. AUTO OPERATOR	4642 WMS 120 VAC	689	LCN
2	EA	SENSOR	8310-3882		LCN
1	EA	SAFETY RAILS	AS REQUIRED		
2	EA	ARMOR PLATE	8400 36" X 1" LDW B-CS	630	IVE
2	EA	KICK PLATE	8400 4" X 1" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	ASTRAGAL	8193AA	AA	ZER

Hardware Group No. 56

1	EA	SLIDING DOOR	BALANCE OF HARDWARE BY SLIDING DOOR MANUFACTURER		
2	EA	CYLINDER	IC CYLINDER AS REQUIRED	612	BES
2	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED	626	BES
1			CARD READER - WORK OF DIVISION 28		
DOOR TO HAVE VIDEO INTERCOM AND DOOR RELEASE BUTTON					

Hardware Group No. 57

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	OFFICE/ENTRY LOCK	L9050HD 06A L583-363	626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED	626	BES
1	EA	SURFACE CLOSER	4050A RW/PA	689	LCN
1	EA	KICK PLATE	8400 10" X 1 1/2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware Group No. 58

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	CLASSROOM LOCK	L9070HD 06A	626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED	626	BES
1	EA	WALL STOP	WS406/407CVX	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

Hardware Group No. 59

1	EA	BARN DOOR TRACK	2610SC	AL	JOH
1	EA	CLASSROOM DEADLOCK	9100BDL-3ST 7200P-ADA TURN	626	ACC

Hardware Group No. 60

2	EA	CONT. HINGE	224XY EPT		628	IVE
2	EA	POWER TRANSFER	EPT10 CON	↗	689	VON
2	EA	ELEC FIRE EXIT HARDWARE	LMRX-MEL-F-25-V-EO-LBRAFL 24 VDC	↗	626	FAL
1	EA	MAGNETIC LOCK	M490 12/24 VDC	↗	628	SCE
2	EA	SURF. AUTO OPERATOR	4642 WMS 120 VAC	↗	689	LCN
2	EA	ACTUATOR PKG	8310-3857T	↗	630	LCN
2	EA	SENSOR	8310-879	↗		LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS		630	IVE
2	EA	KICK PLATE	8400 4" X 1" LDW B-CS		630	IVE
1	EA	GASKETING	488SBK PSA		BK	ZER
2	EA	ASTRAGAL	8193AA		AA	ZER
4	EA	WIRE HARNESS	CON-192P	↗		SCH
2	EA	DOOR CONTACT	679-05HM	↗	BLK	SCE
1	EA	POWER SUPPLY	PS902 BBK FA900 120/240 VAC	↗	LGR	SCE
1			CARD READER - WORK OF DIVISION 28			
1	EA	NOTE	PROVIDE POINT TO POINT WIRING DIAGRAMS			
1	EA	NOTE	PROVIDE RISER WIRING DIAGRAMS			

DOOR NORMALLY CLOSED AND LOCKED.  
MAGLOCK TO BE INSTALLED ON DOOR SWINGING INTO RESIDENT POD.  
PRESENTATION OF VALID CREDENTIAL TO RELEASE MAGLOCK AND RETRACT LATCHBOLTS  
AND ALLOW ENTRY, EITHER MANUALLY OR BY DEPRESSING OUTSIDE ACTUATOR WHICH WILL  
OPEN DOORS VIA AUTOMATIC OPERATOR.

Hardware Group No. 61

3	EA	HINGE	5BB1 4.5 X 4.5 NRP		652	IVE
1	EA	CLASSROOM DEAD LOCK	L463HD XB11-720		626	SCH
1	EA	PERMANENT CORE	PERMANENT IC CORE AS REQUIRED		626	BES
1	EA	OH STOP	90S		652	GLY
1	EA	GASKETING	488SBK PSA		BK	ZER

Hardware Group No. 62

1	EA	PANIC HARDWARE	LD-25-R-EO		626	FAL
1	EA	GATE MAG LOCK	M490G 12/24 VDC	↗	628	SCE
1	EA	POWER SUPPLY	PS902 BBK FA900 120/240 VAC	↗	LGR	SCE
1			CARD READER - WORK OF DIVISION 28			
1	EA	NOTE	PROVIDE POINT TO POINT WIRING DIAGRAMS			
1	EA	NOTE	PROVIDE RISER WIRING DIAGRAMS			

END OF SECTION

## SECTION 08 80 00

### GLAZING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Monolithic glass for interior doors, interior borrowed lites, and interior storefront framing.
  - 2. Insulating glass for aluminum entrance doors, and storefront framing.
  - 3. Glazing sealants and accessories.
- B. Related Requirements:
  - 1. Section 08 83 00 "Mirrors."
  - 2. Section 08 88 13 "Fire-Resistant Glazing."

##### 1.3 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.
- C. IBC: International Building Code.
- D. Interspace: Space between lites of an insulating-glass unit.

##### 1.4 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

##### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. For field-applied glazing sealants used on the interior of the building, documentation including printed statement of VOC content in g/L.

- B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches square.
- C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.
- D. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, manufacturers of insulating-glass units with sputter-coated, low-E coatings, glass testing agency, and sealant testing agency.
- B. Product Certificates: For glass.
- C. Product Test Reports: For tinted glass, coated glass, insulating glass, and glazing sealants, for tests performed by a qualified testing agency.
  - 1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.
- D. Preconstruction adhesion and compatibility test report.
- E. Sample Warranties: For special warranties.

#### 1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved by coated-glass manufacturer.
- B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
- C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
- D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
- E. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.
  - 1. Install glazing in mockups specified in Section 08 41 13 "Aluminum-Framed Entrances and Storefronts" to match glazing systems required for Project, including glazing methods.

## 1.8 PRECONSTRUCTION TESTING

- A. Preconstruction Adhesion and Compatibility Testing: Test each glass product, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.
1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.
  2. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
  3. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
  4. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
  5. Schedule enough time for testing and analyzing results to prevent delaying the Work.
  6. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

## 1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F.

## 1.11 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
1. Warranty Period: Ten (10) years from date of Substantial Completion.
- B. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1. Warranty Period: Ten (10) years from date of Substantial Completion.
- C. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
1. Warranty Period: Ten (10) years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Basis-of-Design Glass Product: Subject to compliance with requirements, provide product indicated in glass schedules or comparable product by one of the following, or equal approved by Professional:
1. AGC Glass Company North America, Inc.
  2. Berkowitz, JE, LP.
  3. Cardinal Glass Industries.
  4. Guardian Industries Corp.
  5. Oldcastle BuildingEnvelope.
  6. Pilkington North America Inc.
  7. PPG Industries, Inc.
  8. Saint-Gobain Corporation.
  9. Schott North America, Inc.
  10. Viracon, Inc.
- B. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
1. Obtain tinted glass from single source from single manufacturer.
  2. Obtain reflective-coated glass from single source from single manufacturer.
- C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

### **2.2 PERFORMANCE REQUIREMENTS**

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Delegated Design: Engage a qualified professional engineer, licensed in the Commonwealth of Pennsylvania, to design glazing.
- C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the International Building Code and ASTM E 1300.



1. Design Wind Pressures: As indicated on Drawings.
  2. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch, whichever is less.
  3. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.
- D. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
- E. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
1. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
  2. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
  3. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

### 2.3 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
1. GANA Publications: "Glazing Manual."
  2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the Safety Glazing Certification Council (SGCC) or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
- D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.
- E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

### 2.4 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.
- B. Tinted Annealed Float Glass: ASTM C 1036, Type I, Class 2 (tinted), Quality-Q3.

- C. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
- D. Heat-Strengthened Float Glass: ASTM C 1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
- E. Ceramic-Coated Spandrel Glass: ASTM C 1048, Type I, Condition B, Quality-Q3.

## 2.5 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190.
  - 1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
  - 2. Spacer: Manufacturer's standard spacer material and construction.
  - 3. Desiccant: Molecular sieve or silica gel, or a blend of both.

## 2.6 GLAZING SEALANTS

- A. General:
  - 1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
  - 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
  - 3. Field-applied sealants used on the interior of the building (defined as inside of the weatherproofing system and applied on-site), shall comply with VOC limits as specified in South Coast Air Quality Management District (SCAQMD) Rule #1168 effective date of July 1, 2005, and rule amendment date of January 7, 2005, and shall have a VOC content of not more than 250 g/L.
  - 4. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
- B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT.

## 2.7 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
  - 1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
  - 2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
  - 1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
  - 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

## 2.8 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, with requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

## 2.9 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
  - 1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
    - a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
  - 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
  - 2. Presence and functioning of weep systems.
  - 3. Minimum required face and edge clearances.

4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

### 3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

F. Provide spacers for glass lites where length plus width is larger than 50 inches.

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.

2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

- J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

### 3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until right before each glazing unit is installed.
- F. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- G. Apply cap bead of elastomeric sealant over exposed edge of tape.

### 3.5 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

### 3.6 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

### 3.7 CLEANING AND PROTECTION

- A. Immediately after installation remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
  - 1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
- C. Remove and replace glass that is damaged during construction period.

### 3.8 MONOLITHIC GLASS SCHEDULE

- A. Glass Type GL-1: Clear annealed float glass unless otherwise indicated.
  - 1. Minimum Thickness: 6 mm.
  - 2. Provide heat-strengthened float glass where indicated and where required to meet specified performance requirements.
  - 3. Provide fully tempered float glass where indicated and where required by codes.
    - a. Provide safety glazing labeling.
- B. Glass Type GL-2: Tinted annealed float glass unless otherwise indicated.
  - 1. Tint Color: As indicated in Drawings.
  - 2. Minimum Thickness: 6 mm.
  - 3. Provide heat-strengthened float glass where indicated and where required to meet specified performance requirements.
  - 4. Provide fully tempered float glass where indicated and where required by codes.
    - a. Provide safety glazing labeling.

### 3.9 INSULATING GLASS SCHEDULE

- A. Glass Type IG-1 & IG-2: Low-E-coated, tinted insulating glass.

1. Basis-of-Design Product: PPG Industries, Inc.; Solarban 60, Azuria.
2. Overall Unit Thickness: 1 inch.
3. Minimum Thickness of Each Glass Lite: 6 mm.
4. Outdoor Lite: Tinted annealed float glass unless otherwise indicated.
5. Tint Color: Gray.
6. Interspace Content: Winter Argon.
7. Indoor Lite: Clear annealed float glass unless otherwise indicated.
8. Low-E Coating: Pyrolytic or sputtered on second or third surface.
9. Winter Nighttime U-Factor: 0.24 maximum.
10. Summer Daytime U-Factor: 0.28 maximum.
11. Visible Light Transmittance: 50 percent minimum.
12. Solar Heat Gain Coefficient: 0.30 maximum.
13. Provide heat-strengthened float glass where indicated and where required to meet specified performance requirements.
14. Provide fully tempered float glass where indicated and where required by codes.
  - a. Provide safety glazing labeling.

B. Glass Type IG-3: Ceramic-coated, low-E, insulating spandrel glass.

1. Basis-of-Design Product: Solarban 60, Azuria.
2. Coating Color: As selected by Architect from manufacturer's full range] [Match Architect's samples.
3. Overall Unit Thickness: 1 inch.
4. Minimum Thickness of Each Glass Lite: 6 mm.
5. Outdoor Lite: Annealed float glass unless otherwise indicated.
6. Interspace Content: Air.
7. Indoor Lite: Annealed float glass unless otherwise indicated.
8. Low-E Coating: Pyrolytic or sputtered on second or third surface.
9. Opaque Coating Location: Fourth surface.
10. Winter Nighttime U-Factor: 0.24 maximum.
11. Summer Daytime U-Factor: 0.28 maximum.
12. Provide heat-strengthened float glass where indicated and where required to meet specified performance requirements.
13. Provide fully tempered float glass where indicated and where required by codes.
  - a. Provide safety glazing labeling.

**END OF SECTION 08 80 00**

## SECTION 08 83 00

### MIRRORS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section includes the following types of silvered flat glass mirrors:
  - 1. Annealed monolithic glass mirrors.
  - 2. Film-backed or laminated glass mirrors qualifying as safety glazing.
- B. Related Requirements:
  - 1. Section 08 80 00 "Glazing" for glass with reflective coatings used for vision and spandrel lites.
  - 2. Section 10 28 00 "Toilet, Bath, and Laundry Accessories" for metal-framed mirrors.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Mirrors. Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.
  - 2. For adhesives used on the interior of the building, include a statement of VOC content in g/L.
- B. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachment details.
- C. Samples: For each type of the following:
  - 1. Mirrors: 12 inches square, including edge treatment on two adjoining edges.
  - 2. Mirror Trim: 12 inches long.

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of mirror and mirror mastic.
- B. Preconstruction Test Reports: From mirror manufacturer indicating that mirror mastic was tested for compatibility and adhesion with mirror backing and substrates on which mirrors are installed.



- C. Sample Warranty: For special warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For mirrors to include in maintenance manuals.

#### 1.6 PRECONSTRUCTION TESTING

- A. Preconstruction Mirror Mastic Compatibility Test: Submit mirror mastic products to mirror manufacturer for testing to determine compatibility of mastic with mirror backing.
  1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.
  2. Testing is not required if data are submitted based on previous testing of mirror mastic products and mirror backing matching those submitted.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect mirrors according to mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

#### 1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

#### 1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.
  1. Warranty Period: Five (5) years from date of Substantial Completion.

### **PART 2 - PRODUCTS**

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by Professional:

1. Binswanger Glass.
2. Gardner Glass Products, Inc.
3. Guardian Industries Corp.
4. Virginia Mirror Company, Inc.

- B. Source Limitations for Mirrors: Obtain mirrors from single source from single manufacturer.
- C. Source Limitations for Mirror Accessories: Obtain mirror glazing accessories from single source.

## 2.2 SILVERED FLAT GLASS MIRRORS

- A. Mirrors, General: ASTM C 1503.
- B. Annealed Monolithic Glass Mirrors: Mirror Glazing Quality, clear.
1. Nominal Thickness:
    - a. 6.0 mm.
- C. Laminated Mirrors: ASTM C 1172, Type II.
1. Glass for Outer Lite: Annealed float glass, Mirror Glazing Quality, clear.
  2. Nominal Thickness for Outer Lite: 3.0 mm.
  3. Glass for Inner Lite: Annealed float glass; ASTM C 1036, Type I (transparent flat glass), Quality-Q3; Class 1 (clear).
  4. Nominal Thickness for Inner Lite: 3.0 mm.
  5. Interlayer: 0.030-inch- thick, clear polyvinyl-butylal.
- D. Safety Glazing Products: For film-backed or laminated mirrors, provide products that comply with 16 CFR 1201, Category II.

## 2.3 MISCELLANEOUS MATERIALS

- A. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- B. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.
- C. Mirror Mastic: An adhesive setting compound, asbestos-free, produced specifically for setting mirrors and certified by both mirror and mastic manufacturer as compatible with glass coating and substrates on which mirrors will be installed.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by Professional:
    - a. Franklin International.
    - b. Laurence, C. R. Co., Inc.
    - c. Liquid Nails Adhesive.
    - d. Palmer Products Corporation.
    - e. Royal Adhesives & Sealants, LLC.
  2. All adhesives used on the interior of the building shall have a VOC content of 70 g/L or less.

- D. Film Backing for Safety Mirrors: Film backing and pressure-sensitive adhesive; both compatible with mirror backing paint as certified by mirror manufacturer.

## 2.4 MIRROR HARDWARE

- A. Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover edges of mirrors in a single piece.
  - 1. Bottom Trim: J-channels formed with front leg and back leg not less than 3/8 and 7/8 inch in height, respectively, and a thickness of not less than 0.04 inch.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by Professional:
      - 1) Andscot Company, Inc.
      - 2) Laurence, C. R. Co., Inc.
      - 3) Stylmark, Inc.
  - 2. Top Trim: J-channels formed with front leg and back leg not less than 5/8 and 1 inch in height, respectively, and a thickness of not less than 0.04 inch.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by Professional:
      - 1) Andscot Company, Inc.
      - 2) Laurence, C. R. Co., Inc.
      - 3) Stylmark, Inc.
  - 3. Finish: Clear bright anodized.
- B. Wood Trim: Size as indicated on the Drawings
- C. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.
- D. Anchors and Inserts: Provide devices as required for mirror hardware installation. Provide toothed or lead-shield, expansion-bolt devices for drilled-in-place anchors. Provide galvanized anchors and inserts for applications on inside face of exterior walls and where indicated.

## 2.5 FABRICATION

- A. Fabricate mirrors in the shop to greatest extent possible.
- B. Fabricate cutouts for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts so they fit closely around penetrations in mirrors.
- C. Mirror Edge Treatment: Rounded polished.
  - 1. Seal edges of mirrors with edge sealer after edge treatment to prevent chemical or atmospheric penetration of glass coating.
  - 2. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.

- D. Film-Backed Safety Mirrors: Apply film backing with adhesive coating over mirror backing paint, as recommended in writing by film-backing manufacturer, to produce a surface free of bubbles, blisters, and other imperfections.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.
- B. Verify compatibility with and suitability of substrates, including compatibility of existing finishes or primers with mirror mastic.
- C. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

#### **3.2 PREPARATION**

- A. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating substrates with mastic manufacturer's special bond coating where applicable.

#### **3.3 INSTALLATION**

- A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.
  - 1. GANA Publications: "Laminated Glazing Reference Manual", "Glazing Manual" and "Mirrors, Handle with Extreme Care: Tips for the Professional on the Care and Handling of Mirrors."
- B. Provide a minimum airspace of 1/8 inch between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.
- C. Install mirrors with mastic and mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.
  - 1. Aluminum J-Channels: Provide setting blocks 1/8 inch thick by 4 inches long at quarter points. To prevent trapping water, provide, between setting blocks, two slotted weeps not less than 1/4 inch wide by 3/8 inch long at bottom channel.
  - 2. Install mastic as follows:
    - a. Apply barrier coat to mirror backing where approved in writing by manufacturers of mirrors and backing material.
    - b. Apply mastic to comply with mastic manufacturer's written instructions for coverage and to allow air circulation between back of mirrors and face of mounting surface.
    - c. After mastic is applied, align mirrors and press into place while maintaining a minimum airspace of 1/8 inch between back of mirrors and mounting surface.

### 3.4 CLEANING AND PROTECTION

- A. Protect mirrors from breakage and contaminating substances resulting from construction operations.
- B. Do not permit edges of mirrors to be exposed to standing water.
- C. Maintain environmental conditions that prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.
- D. Clean exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Clean mirrors as recommended in writing by mirror manufacturer.

**END OF SECTION 08 83 00**

## SECTION 08 88 13

### FIRE-RESISTANT GLAZING

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Fire-protection-rated glazing.
  - 2. Fire-resistance-rated glazing.

##### 1.3 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

##### 1.4 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

##### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Glass Samples: For each type of glass product; 12 inches square.
- C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

##### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For installers and glass testing agency.
- B. Product Certificates: For each type of glass and glazing product, from manufacturer.
- C. Sample Warranties: For special warranties.

## 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

## 1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install fire-resistant glazing until spaces are enclosed and weathertight and temporary HVAC system is operating and maintaining ambient temperature conditions at occupancy levels during the remainder of the construction period.

## 1.10 WARRANTY

- A. Manufacturer's Special Warranty on Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1. Warranty Period: Five (5) years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### 2.1 MANUFACTURERS

- A. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
- B. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

### 2.2 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; deterioration of glazing materials; or other defects in construction.

## 2.3 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organization below unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
  - 1. GANA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
- B. Safety Glazing Labeling: Permanently mark glazing with certification label of the Safety Glazing Certification Council (SGCC) or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, glass thickness, and safety glazing standard with which glass complies.

## 2.4 GLASS PRODUCTS

- A. Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.
- B. Laminated Glass: ASTM C 1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
  - 1. Construction: Laminate glass with polyvinyl butyral interlayer unless fire-protection or fire-resistance rating is based on another product.
  - 2. Interlayer Thickness: Provide thickness as needed to comply with requirements.
  - 3. Interlayer Color: Clear unless otherwise indicated.

## 2.5 FIRE-PROTECTION-RATED GLAZING

- A. Fire-Protection-Rated Glazing: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on positive-pressure testing according to NFPA 257 or UL 9, including the hose-stream test, and shall comply with NFPA 80.
  - 1. Fire-protection-rated glazing required to have a fire-protection rating of 20 minutes shall be exempt from the hose-stream test.
- B. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name; test standard; whether glazing is permitted to be used in doors or openings; if permitted in openings, whether or not glazing has passed the hose-stream test; whether or not glazing meets 450 deg F temperature-rise limitation; and the fire-resistance rating in minutes.
- C. Laminated Ceramic Glazing: Laminated glass made from two plies of clear, ceramic glass; 8-mm total thickness; and complying with 16 CFR 1201, Category II.
  - 1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by Professional:
    - a. Interedge Technologies; Pyran Platinum L.
    - b. Safti First; Pyran Platinum L
    - c. Schott North America, Inc.; Pyran Platinum L.
    - d. Technical Glass Products; FireLite Plus.
    - e. Vetrotech Saint-Gobain; SGG Keralite FR-L.



- D. Laminated Glass with Intumescent Interlayers: Laminated glass made from multiple plies of uncoated, ultraclear float glass; with intumescent interlayers; and complying with 16 CFR 1201, Category II.
1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by Professional:
    - a. InterEdge; Pyrobel.
    - b. Pilkington North America Inc.; Pyrostop.
    - c. Technical Glass Products; Pyrostop.
    - d. Vetrotech Saint-Gobain; Contraflam.

## 2.6 GLAZING ACCESSORIES

- A. Provide glazing gaskets, glazing sealants, glazing tapes, setting blocks, spacers, edge blocks, and other glazing accessories that are compatible with glazing products and each other and are approved by testing agencies that listed and labeled fire-resistant glazing products with which products are used for applications and fire-protection ratings indicated.
- B. Glazing Sealants for Fire-Rated Glazing Products: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT. Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated.
1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by Professional:
    - a. Dow Corning Corporation; 795.
    - b. GE Advanced Materials - Silicones; SilGlaze II SCS2800.
    - c. Tremco Incorporated; Spectrem 2.
  2. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
- C. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
  2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- D. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
  2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

## 2.7 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
- C. Perimeter Insulation for Fire-Resistive Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.

## 2.8 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with manufacturing and installation tolerances, including those for size, squareness, and offsets at corners, and for compliance with minimum required face and edge clearances.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate fire side and protected side. Label or mark units as needed so that fire side and protected side are readily identifiable. Do not use materials that leave visible marks in the completed work.

## 3.3 GLAZING, GENERAL

- A. Use methods approved by testing agencies that listed and labeled fire-resistant glazing products.
- B. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials unless more stringent requirements are indicated, including those in referenced glazing publications.
- C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge

damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

- D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- G. Provide spacers for glass lites where length plus width is larger than 50 inches.
  - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
  - 2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- I. Set glass lites with proper orientation so that coatings face fire side or protected side as specified.
- J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

### 3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until right before each glazing unit is installed.

- F. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- G. Apply cap bead of elastomeric sealant over exposed edge of tape.

### 3.5 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop, so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- D. Install gaskets so they protrude past face of glazing stops.

### 3.6 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial washaway from glass.

### 3.7 CLEANING AND PROTECTION

- A. Immediately after installation, remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
  - 1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.
- C. Remove and replace glass that is damaged during construction period.

### 3.8 FIRE-RESISTANT GLAZING SCHEDULE

- A. Glass Type FPGL-1: 60-minute fire-protection-rated glazing with 450 deg F temperature-rise limitation; laminated glass with intumescent interlayers.

**END OF SECTION 08 88 13**

**SECTION 08 91 00**  
**ALUMINUM LOUVERS**

**PART 1 - GENERAL**

1. STIPULATIONS

- a. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.1

1.2 SECTION INCLUDES

- A. Aluminum louvers as shown on the Drawings and as specified herein, including but not necessarily limited to the following:
1. Continuous blade type, architectural vision louvers.
  2. Concealed snap-in support clips and accessories.
  3. Factory-applied finish system to louver blades.
  4. Field measurements and verification of all openings and all conditions of the louver installations.

1.3 RELATED SECTIONS

- A. Section 05 12 00 - Structural Steel: Metal Framing.
- B. Section 05 50 00 - Metal Fabrications: Frames and supports.
- C. Section 09 91 13 – Exterior Paints and Coatings: Field applied paint finish.

1.4 REFERENCES

- A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
- B. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.
- C. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- D. ASTM B 449 - Standard Specification for Chromates on Aluminum.
- E. ASTM D 1730 - Standard Practices for Preparation of Aluminum and Aluminum-Alloy Surfaces for Painting.
- F. ASTM D 2244 - Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.

- G. ASTM D 4214 - Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films.

## 1.5 COORDINATION

- A. Coordinate Work with other operations and installation of roofing materials to avoid damage to installed insulation and membrane materials.

## 1.6 ACTION SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00:
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
  - 1. Preparation instructions and recommendations.
  - 2. Load tables showing louver span capacities.
  - 3. Storage and handling requirements and recommendations.
  - 4. Installation methods.
- C. Shop Drawings:
  - 1. Layout and erection drawings showing typical cross sections and dimensioned locations of all louver blades, trees, splices and corners. Include erection drawings, elevations, and details where applicable.
- D. Selection Samples:
  - 1. For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
- E. Verification Samples:
  - 1. For each product specified, two samples, minimum 12 inches (305 mm) long, representing actual product shape and dimensions.

## 1.7 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificates: Certify products meet or exceed specified requirements.
- B. Warranties: 3 signed copies of the following:
  - 1. Louver Units including paint finish.

## 1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer with a minimum five years documented experience in producing architectural louver systems.
- B. Provide aluminum louvers by a firm having undivided responsibility for the entire aluminum louver system design, fabrication and installation, except as otherwise specified herein.
- C. Provide aluminum louvers in strict accordance with state and local building codes and ordinances and conforming to applicable wind load factors relative to framing and anchorage.
- D. Pre-Installation Meeting:
  - 2. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03

– Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.

3. Convene at job site, at least seven calendar days prior to scheduled beginning of construction activities of this section, to review requirements of this section.
  4. Require attendance by representatives of the installing subcontractor (who will represent the system manufacturer), the mechanical subcontractors and other entities affected by construction activities of this section.
  5. Notify Architect four calendar days in advance of scheduled meeting date.
- E. Provide factory-applied finish aluminum system in accordance with AAMA Specifications, AAMA 2605 for Superior Performance Organic Coatings on Architectural Extrusions and Panels.

#### 1.9 DELIVERY, HANDLING AND STORAGE

- A. Deliver louver components to the project site clearly marked for proper identification.
- B. Receive, handle and store materials in conformance with the manufacturers printed instructions.
- C. Store louver components in accordance with manufacturer's instructions, above ground, in dunnage and protected from weather, construction activities and other causes of damage or loss.
- D. Handling: Use a forklift or crane to move material. Do not lift the bundles by the metal bands.
  1. Fork Lift: Spread the forks as far as possible to balance the load. Drive slowly when moving long bundles over uneven surfaces to avoid tipping the load
  2. Crane: Position the canvas sling straps so that the space between the straps is at least 1/3 the length of the bundle. Use sling straps with looped ends running one end of the strap through the loop at the other end to cinch the bundle when lifted. When setting the load on the roof, put wood blocks under it to protect the roof and allow space to remove the sling straps.
  3. Roof Placement: Spread the bundles and crates out as much as possible to avoid overloading the roof structure. Place the material directly over major supports such as beams or trusses.

#### 1.10 PROJECT CONDITIONS

- A. Field Measurements: Verify louver openings by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
  1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating louvers without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

#### 1.11 WARRANTY

- A. Louvers:
  1. Provide written warranty, stating that the louvers, exclusive of paint finish, will be free of faults and defects for a period of twenty (20) years from the date of final acceptance by the Owner.
  2. Provide warranty signed by the louver manufacturer and installing contractor.



- B. Paint Finish:
1. Provide written warranty stating that the paint finish applied on all louver components will retain its' film integrity, color and chalk as defined below for a period of ten (10) years from the date of final acceptance by the Owner:
    - a. Film integrity shall be defined as the absence of peeling, checking, chipping or cracking.
    - b. Color Change shall be defined as freedom from fade or change as warranted in  $\Delta E$  units calculated in accordance with ASTM D 2244. Color Change is measured on an exposed painted surface that has been cleaned of surface soils and chalk and then compared to corresponding values measured on the original or unexposed coated surface.
    - c. Chalk or Oxidation shall be defined as a numerical rating as warranted when measured in accordance with the standard procedures specified in ASTM D 4214.
  2. Provide warranty signed by the louver manufacturer and paint finish applicator (if separate from manufacturer).
- C. The above warranties are in addition to, and not a limitation of, other rights the Owner may under the Contract Documents.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Design Loads: Comply with Building Code for site location and building height.
1. Design to resist ASCE 7 - Minimum Design Loads for Buildings and Other Structures.
  2. Design all materials, assembly and attachments to resist snow, wind, suction and uplift loading at any point without damage or permanent set.
- B. Structural Design: Prepare structural design calculations for louver assemblies including blades, clips, trees, fasteners and attachment to structure.
1. Design and provide louvers to withstand a wind load of [x] psf inward and [x] psf outward with a deflection in both vertical and horizontal members not to exceed  $L/180$ .
- C. Thermal Movement: Normal thermal movement is defined as that resulting from a 120 degrees F maximum change (range) in ambient temperature. Base design calculations on actual surface temperatures of metals due to both solar heat gain and night time sky heat loss.
- D. Anchors and Connections:
1. Anchors, connections and assemblies connecting the louvers and associated fabrications to the supporting construction are shown on the Drawings as suggested locations for the louver manufacturer/installer's information. The louver manufacturer/installer is responsible for the structural design and placement of the connections and anchors, including all connecting hardware, accessories and reinforcing necessary for fabrication, and installation of the louvers and associated fabrications.
  2. The louver manufacturer is to notify the Architect in writing prior to the submittal of shop drawings of any changes in the proposed locations of connections and anchors.

3. The Architect's review of shop drawings is not to be construed as removing responsibility from the louver manufacturer/installer for structural failures related to design, fabrication, installation, and fabrication services.

## 2.2 MANUFACTURERS

1. Basis-of-Design Product: Subject to compliance with requirements, provide Roof Screen Manufacturing or comparable product by one of the following, or equal approved by Professional:
  - a. Airolite Company, LLC (The).
  - b. All-Lite Architectural Products.
  - c. Construction Specialties, Inc.
  - d. Reliable Products, Inc.
  - e. Ruskin Company.

## 2.3 PRODUCTS

- A. Basis-of-Design Manufacturer and Louver: RoofScreen Mfg.
  1. VisionGuard L10 Angled Louver.

## 2.4 MATERIALS

- A. Aluminum Extrusions: ASTM B 221, 6063-T6 alloy and temper.
- B. Fasteners:
  1. Provide exposed fasteners of stainless steel or carbon steel with factory applied protective coating, with finish color coating to match the finish on aluminum.
  2. Provide fasteners not exposed to view of stainless steel or carbon steel with factory applied protective coating.

## 2.5 FABRICATION

- A. Fabricate louvers with close-fitting, field-made splice joints in blades designed to permit expansion and contraction without deforming blades or framework and with supporting members and hardware concealed from front edges of blades so blades have continuous appearance.
- B. General:
  1. Fabricate all units to produce uniform sight lines and to be level, plumb and in same plane as adjacent panels.
  2. Accurately fabricate all joints for proper fit.
  3. Protect exposed surfaces against damage from scratches and discoloration.
- C. Louvers:
  1. Fabricate continuous blade louvers from minimum 0.1 inch thick extruded aluminum to shapes and configurations shown on the Drawings with welded joints.
  2. Provide support clips from minimum 0.125 inch thick extruded aluminum to comply with specified performance criteria and manufacturer's fabrication procedures and standards.
  3. Provide vertical supports ("trees") from minimum 3 inch by 3 inch by 0.188 inch thick extruded aluminum angles to comply with specified performance criteria and manufacturer's fabrication procedures and standards, at spacings not further apart than recommended by manufacturer.
  4. Corners:

- a. Provide inside and outside corners fabricated from 6 inch by 6 inch by 0.100 inch thick aluminum trim, painted to match louver blades, to be fastened with exposed fasteners.
  - b. Provide inside and outside corners fabricated from mitered and welded louver blades that extend 24 inches in each direction. Finish corners after welding is complete.
- D. Provide all accessories and materials for fabrication, assembly and installation required to provide a complete and warranted louver installation.

## 2.6 FINISH OF ALUMINUM

- A. Provide all louver members and accessories free of scratches and serious blemishes affecting the finish system.
- B. Fluoropolymer Paint Finish: Factory finish all louver members, accessories, and trim members with fluoropolymer resin base 2 coat paint system containing 70 percent polyvinylidene fluoride (PVDF) fluoropolymer resin. Provide paint finish system consisting of the following:
- 1. Processed and clean aluminum in accordance with ASTM B 449, Section 5.
  - 2. Apply pretreatment conversion coating in accordance with ASTM D 1730, Type B, Method 5 or 7 with pretreatment conversion coating weighing not less than 30 mg per sq ft.
  - 3. Prime aluminum with thermo-cured inhibitive primer averaging not less than 0.2 to 0.4 mil dry film thickness.
  - 4. Color coat applied to a minimum thickness of 1.0 to 1.3 mil dry film thickness.
  - 5. Factory apply the finish paint system in accordance with the manufacturer's printed requirements and performance specifications and the AAMA specification Ref. AAMA 2605 for Superior Performance Organic Coatings on Aluminum Extrusions and Panels.
- C. Color selection will be made by the Architect from manufacturer's standard colors.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. Examine all surfaces to receive parts of the work specified herein. Verify all dimensions of in-place and subsequent construction. Installation of louvers constitutes acceptance of the existing conditions.

### 3.2 INSTALLATION

- A. Set all items in their correct locations as shown on the final reviewed shop drawings, level, square, plumb and at proper elevations and in alignment with other work.
- B. Assemble and anchor the various components to allow for expansion and contraction, maintaining a watertight installation.

### 3.3 CLEANING & PROTECTION

- A. After erection, protect exposed portions of the louvers from damage.

- B. Just prior to final acceptance, remove protective coverings and clean surfaces with plain water or if required, with a solution as recommended by manufacturer of finish coating system.
- C. Touch up finish coat system of all imperfections as recommended by manufacturer of finish coating system.
- D. Remove and replace any component that cannot be successfully repaired at no additional cost to the Owner.

**END OF SECTION**

## SECTION 08 91 19

### FIXED LOUVERS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:

- 1. Fixed, extruded-aluminum louvers.
- 2. Fixed, formed-metal acoustical louvers.

- B. Related Requirements:

- 1. Section 08 11 13 "Hollow Metal Doors and Frames" for louvers in hollow-metal doors.
- 2. Section 08 14 16 "Flush Wood Doors" for louvers in flush wood doors.

##### 1.3 DEFINITIONS

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Horizontal Louver: Louver with horizontal blades (i.e., the axes of the blades are horizontal).
- C. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- 1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

- 1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
- 2. Show mullion profiles and locations.

- C. Samples: For each type of metal finish required.

- D. Delegated-Design Submittal: For louvers indicated to comply with structural[ **and seismic**] performance requirements, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

#### 1.6 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

### **PART 2 - PRODUCTS**

#### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

#### 2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer licensed in the Commonwealth of Pennsylvania, using structural and seismic performance requirements and design criteria indicated.
- B. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
  - 1. Wind Loads: Determine loads based on pressures as indicated on Drawings.
- C. Seismic Performance: Louvers, including attachments to other construction, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. Component Importance Factor: 1.0.
- D. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.
- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

- F. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

## 2.3 FIXED, EXTRUDED-ALUMINUM LOUVERS

### A. Horizontal, Drainable-Blade Louver:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Airolite Company, LLC (The); K638HP Drainable Louver or comparable product by one of the following, or equal approved by Professional:
  - a. Airolite Company, LLC (The).
  - b. All-Lite Architectural Products.
  - c. Construction Specialties, Inc.
  - d. Reliable Products, Inc.
  - e. Ruskin Company; Tomkins PLC.
2. Louver Depth: 4 inches.
3. Frame and Blade Nominal Thickness: Not less than 0.080 inch.
4. Mullion Type: Exposed.
5. Louver Performance Ratings:
  - a. Free Area: Not less than 8.0 sq. ft. for 48-inch- wide by 48-inch- high louver.
  - b. Point of Beginning Water Penetration: Not less than 1000 fpm.
  - c. Air Performance: Not more than 0.15-inch wg static pressure drop at 1000-fpm free-area velocity.
6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

## 2.4 LOUVER SCREENS

### A. General: Provide screen at each exterior louver.

1. Screen Location for Fixed Louvers: Interior face.
2. Screening Type: Bird screening.

### B. Louver Screen Frames: Same type and form of metal as indicated for louver to which screens are attached.

### C. Louver Screening for Aluminum Louvers:

1. Bird Screening: Aluminum, 1/2-inch- square mesh, 0.063-inch wire.
  - a. Locations: Provide behind louver areas for mechanical intake or exhaust of air.
2. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch wire.
  - a. Locations: Provide behind other louver areas or vents not requiring bird screens.

### D. Louver Screening for Galvanized-Steel Louvers:

1. Bird Screening: Galvanized steel, 1/2-inch- square mesh, 0.041-inch wire.

## 2.5 BLANK-OFF PANELS

- A. Insulated, Blank-Off Panels: Laminated panels consisting of an insulating core surfaced on back and front with metal sheets and attached to back of louver.
  - 1. Thickness: 1 inch.
  - 2. Metal Facing Sheets: Aluminum sheet, not less than 0.032-inch nominal thickness.
  - 3. Metal Facing Sheets: Galvanized-steel sheet, not less than 0.028-inch, 24-gage nominal thickness.
  - 4. Insulating Core: Rigid, glass-fiber-board insulation or extruded-polystyrene foam.
  - 5. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard extruded-aluminum-channel frames, not less than 0.080-inch nominal thickness, with corners mitered and with same finish as panels.
  - 6. Seal perimeter joints between panel faces and louver frames with gaskets or sealant.
  - 7. Panel Finish: Same finish applied to louvers.
  - 8. Attach blank-off panels with clips.

## 2.6 MATERIALS

- A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5, T-52, or T6.
- B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Galvanized-Steel Sheet: ASTM A 653/A 653M, G60 zinc coating, mill phosphatized.
- D. Fasteners: Use types and sizes to suit unit installation conditions.
  - 1. Use Phillips flat-head screws for exposed fasteners unless otherwise indicated.
  - 2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
  - 3. For fastening galvanized steel, use hot-dip-galvanized steel or 300 series stainless-steel fasteners.
  - 4. For color-finished louvers, use fasteners with heads that match color of louvers.
- E. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed for masonry, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
- F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

## 2.7 FABRICATION

- A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.



1. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern unless horizontal mullions are indicated.
  2. Horizontal Mullions: Provide horizontal mullions at joints unless continuous vertical assemblies are indicated.
- C. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.
- D. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
1. Frame Type: Channel unless otherwise indicated.
- E. Include supports, anchorages, and accessories required for complete assembly.
- F. Provide vertical mullions of type and at spacings indicated, but not more than is recommended by manufacturer, or 72 inches o.c., whichever is less.
1. Exposed Mullions: Where indicated, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.
- G. Provide subsills made of same material as louvers or extended sills for recessed louvers.
- H. Join frame members to each other and to fixed louver blades with fillet welds concealed from view, threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

## 2.8 ALUMINUM FINISHES

- A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
1. Color and Gloss: As selected by Architect from manufacturer's full range.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

### 3.3 INSTALLATION

- A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Protect unpainted galvanized and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.
- F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 07 92 00 "Joint Sealants" for sealants applied during louver installation.

### 3.4 ADJUSTING AND CLEANING

- A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- C. Restore louvers damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

**END OF SECTION 08 91 19**

## SECTION 09 21 16.23

### GYPSUM BOARD SHAFT WALL ASSEMBLIES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes: Gypsum board shaft wall assemblies for the following:
  - 1. Shaft enclosures.
  - 2. Chase enclosures.
- B. Related Requirements:
  - 1. Section 09 29 00 "Gypsum Board" for applying and finishing panels in gypsum board shaft wall assemblies.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each component of gypsum board shaft wall assembly.

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Fire-Test-Response Reports: From a qualified independent testing and inspecting agency substantiating each gypsum board shaft wall assembly's required fire-resistance rating.
- B. Evaluation Reports: For shaft wall assemblies, from ICC-ES.

##### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

##### 1.6 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or with gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Do not install interior products until installation areas are enclosed and conditioned.

- C. Do not install panels that are wet, moisture damaged, or mold damaged.
  - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
  - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: Provide materials and construction identical to those of assemblies tested according to ASTM E 90 and classified according to ASTM E 413 by a testing and inspecting agency.

### **2.2 GYPSUM BOARD SHAFT WALL ASSEMBLIES**

- A. Fire-Resistance Rating: As indicated on Drawings by design designation from UL's "Fire-Resistance Directory.
- B. STC Rating: As indicated on Drawings, 51 minimum.
- C. Studs: Manufacturer's standard profile for repetitive members, corner and end members, and fire-resistance-rated assembly indicated.
  - 1. Depth: As indicated on Drawings.
  - 2. Minimum Base-Metal Thickness: 0.018 inch, 25 gage.
- D. Runner Tracks: Manufacturer's standard J-profile track with manufacturer's standard long-leg length, but at least 2 inches long and matching studs in depth.
  - 1. Minimum Base-Metal Thickness: Matching steel studs.
- E. Room-Side Finish: Gypsum board unless otherwise indicated.
- F. Shaft-Side Finish: As indicated by fire-resistance-rated assembly design designation.
- G. Insulation: Sound attenuation blankets.

### **2.3 PANEL PRODUCTS**

- A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.
- B. Gypsum Shaftliner Board, Type X: ASTM C 1396/C 1396M; manufacturer's proprietary fire-resistive liner panels with paper faces.

1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by Professional:
    - a. CertainTeed Corp.; ProRoc Shaftliner.
    - b. Georgia-Pacific Gypsum LLC, Subsidiary of Georgia Pacific; ToughRock Fireguard Shaftliner.
    - c. Lafarge North America, Inc.; Firecheck Type X Shaftliner.
    - d. National Gypsum Company; Gold Bond Brand Fire-Shield Shaftliner.
  2. Thickness: 1 inch.
  3. Long Edges: Double bevel.
- C. Gypsum Shaftliner Board, Moisture- and Mold-Resistant Type X: ASTM C 1396/C 1396M; manufacturer's proprietary fire-resistive liner panels with moisture- and mold-resistant core and surfaces.
1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by Professional:
    - a. CertainTeed Corp.; ProRoc Moisture and Mold Resistant Shaftliner.
    - b. Georgia-Pacific Gypsum LLC, Subsidiary of Georgia Pacific; Dens-Glass Ultra Shaftliner.
    - c. Lafarge North America, Inc.; Firecheck Moldcheck Type X Shaftliner.
    - d. National Gypsum Company; Gold Bond Brand Fire-Shield Shaftliner XP.
    - e. USG Corporation; Sheetrock Brand Mold Tough Gypsum Liner Panel.
  2. Thickness: 1 inch.
  3. Long Edges: Double bevel.
  4. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
- D. Gypsum Board: As specified in Section 09 29 00 "Gypsum Board."

## 2.4 NON-LOAD-BEARING STEEL FRAMING

- A. Steel Framing Members: Comply with ASTM C 645 requirements for metal.
1. Protective Coating: Coating with equivalent corrosion resistance of ASTM A 653/A 653M, G40 unless otherwise indicated.

## 2.5 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with manufacturer's written recommendations.
- B. Trim Accessories: Cornerbead, edge trim, and control joints of material and shapes as specified in Section 09 29 00 "Gypsum Board" that comply with gypsum board shaft wall assembly manufacturer's written recommendations for application indicated.
- C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 inch, 20 gage, to 0.112 inch thick.

- D. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.
  - 1. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing according to ASTM E 488 conducted by a qualified testing agency.
  - 2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing according to ASTM E 1190 conducted by a qualified testing agency.
- E. Sound Attenuation Blankets: As specified in Section 09 29 00 "Gypsum Board."
- F. Acoustical Sealant: As specified in Section 07 92 19 "Acoustical Joint Sealants."

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine substrates to which gypsum board shaft wall assemblies attach or abut, with Installer present, including hollow-metal frames, elevator hoistway door frames, cast-in anchors, and structural framing. Examine for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 PREPARATION**

- A. Sprayed Fire-Resistive Materials: Coordinate with gypsum board shaft wall assemblies so both elements of Work remain complete and undamaged. Patch or replace sprayed fire-resistive materials removed or damaged during installation of shaft wall assemblies to comply with requirements specified in Section 07 81 00 "Applied Fireproofing."
- B. After sprayed fire-resistive materials are applied, remove only to extent necessary for installation of gypsum board shaft wall assemblies and without reducing the fire-resistive material thickness below that which is required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

#### **3.3 INSTALLATION**

- A. General: Comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, and ASTM C 754 other than stud-spacing requirements.
- B. Do not bridge building expansion joints with shaft wall assemblies; frame both sides of expansion joints with furring and other support.

- C. Install supplementary framing in gypsum board shaft wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, wall-mounted door stops, and similar items that cannot be supported directly by shaft wall assembly framing.
  - 1. Reinforcing: Where handrails directly attach to gypsum board shaft wall assemblies, provide galvanized steel reinforcing strip with 0.033-inch, 20 gage minimum thickness of base metal (uncoated), accurately positioned and secured behind at least one layer of face panel.
- D. Penetrations: Install supplementary steel framing around perimeter of penetration behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.
- E. Isolate perimeter of gypsum panels from building structure, while maintaining continuity of fire-rated construction.
- F. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect while maintaining fire-resistance rating of gypsum board shaft wall assemblies.
- G. Sound-Rated Shaft Wall Assemblies: Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly. Install acoustical sealant to withstand dislocation by air pressure differential between shaft and external spaces; maintain an airtight and smoke-tight seal; and comply with manufacturer's written instructions or ASTM C 919, whichever is more stringent.
- H. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

### 3.4 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged, or mold damaged.
  - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
  - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

**END OF SECTION 09 21 16.23**

## SECTION 09 22 16

### NON-STRUCTURAL METAL FRAMING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:

- 1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
  - 2. Suspension systems for interior gypsum ceilings and soffits.

- B. Related Requirements:

- 1. Section 05 40 00 "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For dimpled steel studs and runners and firestop tracks, from ICC-ES.

#### PART 2 - PRODUCTS

##### 2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: Provide materials and construction identical to those tested according to ASTM E 119.
- B. STC-Rated Assemblies: Provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413.

##### 2.2 FRAMING SYSTEMS

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.



1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
  2. Protective Coating: ASTM A 653/A 653M, G40, no equivalent coatings allowed hot-dip galvanized unless otherwise indicated.
- B. Studs and Runners: ASTM C 645.
1. Minimum Base-Metal Thickness: 0.018 inch, 25 gage.
  2. Depth: As indicated on Drawings.
- C. Slip-Type Head Joints: Where indicated, provide one of the following in thickness not less than indicated for studs and in width to accommodate depth of studs:
1. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- deep flanges and fastened to studs, and outer runner sized to friction fit inside runner.
  2. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes due to deflection of structure above.
- D. Firestop Tracks: Manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by Professional, or equal approved by Professional:
    - a. Fire Trak Corp.; Fire Trak System attached to studs with Fire Trak Posi Klip.
    - b. Grace Construction Products; FlameSafe FlowTrak System.
    - c. Metal-Lite, Inc.; The System.
- E. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
1. Minimum Base-Metal Thickness: 0.018 inch, 25 gage.
- F. Cold-Rolled Channel Bridging: Steel, 0.053-inch minimum base-metal thickness, with minimum 1/2-inch- wide flanges.
1. Depth: As indicated on Drawings.
  2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.079-inch-, 14 gage, thick, galvanized steel.
- G. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
1. Minimum Base-Metal Thickness: 0.018 inch, 25 gage.
  2. Depth: 7/8 inch.
- H. Resilient Furring Channels: 1/2-inch- deep, steel sheet members designed to reduce sound transmission.
1. Configuration: Asymmetrical or hat shaped.
- I. Cold-Rolled Furring Channels: 0.053-inch, 16 gage, uncoated-steel thickness, with minimum 1/2-inch- wide flanges.
1. Depth: As indicated on Drawings.

2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum uncoated-steel thickness of 0.033 inch.
  3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.
- J. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum uncoated-metal thickness of 0.018 inch, 25 gage, and depth required to fit insulation thickness indicated.

## 2.3 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.
- B. Hanger Attachments to Concrete:
1. Anchors: Capable of sustaining a load equal to 5 times that imposed as determined by ASTM E 488.
    - a. Type: Postinstalled, expansion anchor.
- C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.
- D. Flat Hangers: Steel sheet, 1 by 3/16 inch by length indicated.
- E. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch, 16 gage, and minimum 1/2-inch- wide flanges.
1. Depth: 1-1/2 inches.
- F. Furring Channels (Furring Members):
1. Cold-Rolled Channels: 0.053-inch, 16 gage, uncoated-steel thickness, with minimum 1/2-inch- wide flanges, 3/4 inch deep.
  2. Steel Studs and Runners: ASTM C 645.
    - a. Minimum Base-Metal Thickness: 0.018 inch, 25 gage.
    - b. Depth: As indicated on Drawings.
  3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.
    - a. Minimum Base-Metal Thickness: 0.018 inch, 25 gage.
  4. Resilient Furring Channels: 1/2-inch- deep members designed to reduce sound transmission.
    - a. Configuration: Asymmetrical or hat shaped.

## 2.4 AUXILIARY MATERIALS

- A. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

- B. Isolation Strip at Exterior Walls: Provide asphalt-saturated organic felt or foam gasket.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 PREPARATION**

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
  - 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.
- B. Coordination with Sprayed Fire-Resistive Materials:
  - 1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.
  - 2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

#### **3.3 INSTALLATION, GENERAL**

- A. Installation Standard: ASTM C 754.
  - 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- C. Install bracing at terminations in assemblies.
- D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

### 3.4 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
  - 1. Single-Layer Application: 16 inches o.c. unless otherwise indicated.
  - 2. Multilayer Application: 16 inches o.c. unless otherwise indicated.
  - 3. Tile Backing Panels: 16 inches o.c. unless otherwise indicated.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
  - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
  - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
    - a. Install two studs at each jamb unless otherwise indicated.
    - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
    - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
  - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
  - 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
    - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
  - 5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
- E. Direct Furring:
  - 1. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
- F. Resilient Furring Channels: Install resilient furring channels with the open side facing up, toward the top of the wall, and flange facing down. The lowest row of resilient channel, starting at the floor level, can be installed with the open side down to facilitate the connection of the resilient channel to the stud.
- G. Z-Furring Members:

1. Erect insulation, specified in Section 07 21 00 "Thermal Insulation," vertically and hold in place with Z-furring members spaced 24 inches o.c.
  2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
  3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.
- H. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

### 3.5 INSTALLING SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
    - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
  2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
    - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
  3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
  4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
  5. Do not attach hangers to steel roof deck.
  6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
  7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
  8. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.

- F. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

**END OF SECTION 09 22 16**

## SECTION 09 29 00

### GYPSUM BOARD

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

###### A. Section Includes:

1. Interior gypsum board.
2. Exterior gypsum board for ceilings and soffits.
3. Tile backing panels.

###### B. Related Requirements:

1. Section 06 16 00 "Sheathing" for gypsum sheathing for exterior walls.
2. Section 09 21 16.23 "Gypsum Board Shaft Wall Assemblies" for metal shaft-wall framing, gypsum shaft liners, and other components of shaft-wall assemblies.
3. Section 09 22 16 "Non-Structural Metal Framing" for non-structural framing and suspension systems that support gypsum board panels.

##### 1.3 ACTION SUBMITTALS

###### A. Product Data: For each type of product, including the following:

1. For adhesives used on the interior of the building to laminate gypsum board panels to substrates, include a statement of VOC content in g/L.
2. For acoustical sealants used on the interior of the building, include a statement of VOC content in g/L.

##### 1.4 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

##### 1.5 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

- C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
  - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
  - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

### **2.2 GYPSUM BOARD, GENERAL**

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

### **2.3 INTERIOR GYPSUM BOARD**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by Professional:
  - 1. CertainTeed Corp.
  - 2. Georgia-Pacific Gypsum LLC.
  - 3. Lafarge North America Inc.
  - 4. National Gypsum Company.
  - 5. USG Corporation.
- B. Gypsum Wallboard: ASTM C 1396/C 1396M.
  - 1. Thickness: 5/8 inch.
  - 2. Long Edges: Tapered.
- C. Gypsum Board, Type X: ASTM C 1396/C 1396M.
  - 1. Thickness: 5/8 inch.
  - 2. Long Edges: Tapered.
- D. Flexible Gypsum Board: ASTM C 1396/C 1396M. Manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.
  - 1. Thickness: 1/4 inch.
  - 2. Long Edges: Tapered.



- E. Gypsum Ceiling Board: ASTM C 1396/C 1396M.
  - 1. Thickness: 1/2 inch.
  - 2. Long Edges: Tapered.
  
- F. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.
  - 1. Core: As indicated on Drawings.
  - 2. Long Edges: Tapered.
  - 3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

## 2.4 SPECIALTY GYPSUM BOARD

- A. Glass-Mat Interior Gypsum Board: ASTM C 1658/C 1658M. With fiberglass mat laminated to both sides. Specifically designed for interior use.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following, or equal approved by Professional:
    - a. Georgia-Pacific Gypsum LLC; DensArmour Plus.
  - 2. Core: As indicated on Drawings.
  - 3. Long Edges: Tapered.
  - 4. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
  
- B. Acoustically Enhanced Gypsum Board: ASTM C 1396/C 1396M. Multilayer products constructed of two layers of gypsum boards sandwiching a viscoelastic sound-absorbing polymer core.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. National Gypsum Company; Sound Break.
    - b. Quiet Solution, Quiet Rock.
  - 2. Core: As indicated on Drawings.
  - 3. Long Edges: Tapered.

## 2.5 EXTERIOR GYPSUM BOARD FOR CEILINGS AND SOFFITS

- A. Exterior Gypsum Soffit Board: ASTM C 1396/C 1396M, with manufacturer's standard edges.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by Professional:
    - a. CertainTeed Corp.
    - b. Georgia-Pacific Gypsum LLC.
    - c. Lafarge North America Inc.
    - d. National Gypsum Company.
    - e. USG Corporation.

2. Core: As indicated on Drawings.

## 2.6 TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Board: ASTM C 1178/C 1178M, with manufacturer's standard edges.
  1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following, or equal approved by Professional:
    - a. CertainTeed Corp.; GlasRoc Tile Backer.
    - b. Georgia-Pacific Gypsum LLC; DensShield Tile Backer.
  2. Core: As indicated on Drawings.
  3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
- B. Cementitious Backer Units: ANSI A118.9 and ASTM C 1288 or 1325, with manufacturer's standard edges.
  1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by Professional:
    - a. C-Cure; C-Cure Board 990.
    - b. CertainTeed Corp.; FiberCement BackerBoard.
    - c. Custom Building Products; Wonderboard.
    - d. FinPan, Inc.; Util-A-Crete Concrete Backer Board.
    - e. National Gypsum Company, Permabase Cement Board.
    - f. USG Corporation; DUROCK Cement Board.
  2. Thickness: 5/8 inch.
  3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

## 2.7 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
  1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
  2. Shapes:
    - a. Cornerbead.
    - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
    - c. Expansion (control) joint.
    - d. Curved-Edge Cornerbead: With notched or flexible flanges.
- B. Exterior Trim: ASTM C 1047.
  1. Material: Hot-dip galvanized steel sheet, plastic, or rolled zinc.
  2. Shapes:
    - a. Cornerbead.
    - b. LC-Bead: J-shaped; exposed long flange receives joint compound.

- c. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.

C. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by Professional:
  - a. Fry Reglet Corp.
  - b. Gordon, Inc.
  - c. Pittcon Industries.
2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, Alloy 6063-T5.
3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

## 2.8 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.
2. Exterior Gypsum Soffit Board: Paper.
3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
4. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
  - a. Use setting-type compound for installing paper-faced metal trim accessories.
3. Fill Coat: For second coat, use drying-type, all-purpose compound.
4. Finish Coat: For third coat, use drying-type, all-purpose compound.

D. Joint Compound for Exterior Applications:

1. Exterior Gypsum Soffit Board: Use setting-type taping compound and setting-type, sandable topping compound.

E. Joint Compound for Tile Backing Panels:

1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
2. Cementitious Backer Units: As recommended by backer unit manufacturer.

## 2.9 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
  - 1. Laminating adhesives used on the interior of the building shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
  - 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033, 20 gage, to 0.112 inch thick.
  - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing).
- E. Acoustical Joint Sealant: ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings as demonstrated by testing according to ASTM E 90.
  - 1. Products: Subject to compliance with requirements, **provide one of the following**:
    - a. Accumetric LLC; BOSS 824 Acoustical Sound Sealant.
    - b. Grabber Construction Products; Acoustical Sealant GSC.
    - c. Pecora Corporation; AC-20 FTR at fire-rated construction, AIS-919 at non-fire-rated construction.
    - d. Specified Technologies, Inc.; Smoke N Sound Acoustical Sealant.
    - e. USG Corporation; SHEETROCK Acoustical Sealant.
  - 2. Acoustical joint sealant used on the interior of the building shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. Thermal Insulation: As specified in Section 07 21 00 "Thermal Insulation."
- G. Vapor Retarder: As specified in Section 07 21 00 "Thermal Insulation."

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
  - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
  - 2. Fit gypsum panels around ducts, pipes, and conduits.
  - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. Resilient Furring Channels: Install resilient furring channels with the open side facing up, toward the top of the wall, and flange facing down. The lowest row of resilient channel, starting at the floor level, can be installed with the open side down to facilitate the connection of the resilient channel to the stud.
- J. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- K. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

### 3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:

1. Wallboard Type: As indicated on Drawings.
2. Type X: Where required for fire-resistance-rated assembly.
3. Flexible Type: As indicated on Drawings.
4. Ceiling Type: As indicated on Drawings.
5. Moisture- and Mold-Resistant Type: As indicated on Drawings.
6. Glass-Mat Interior Type: As indicated on Drawings.
7. Acoustically Enhanced Type: As indicated on Drawings.

B. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
  - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
  - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:

1. On ceilings, apply gypsum board indicated for base layers before applying face layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
3. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

- D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

### 3.4 APPLYING EXTERIOR GYPSUM PANELS FOR CEILINGS AND SOFFITS

- A. Apply panels perpendicular to supports, with end joints staggered and located over supports.

1. Install with 1/4-inch open space where panels abut other construction or structural penetrations.
2. Fasten with corrosion-resistant screws.

### 3.5 APPLYING TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Panels: Comply with manufacturer's written installation instructions and install at showers, tubs, and where indicated. Install with 1/4-inch gap where panels abut other construction or penetrations.
- B. Cementitious Backer Units: ANSI A108.11, at locations indicated to receive tile.

### 3.6 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
  1. Cornerbead: Use at outside corners unless otherwise indicated.
  2. LC-Bead: Use at exposed panel edges.
  3. Curved-Edge Cornerbead: Use at curved openings.
- D. Exterior Trim: Install in the following locations:
  1. Cornerbead: Use at outside corners.
  2. LC-Bead: Use at exposed panel edges.
- E. Aluminum Trim: Install in locations indicated on Drawings.

### 3.7 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
  1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
  2. Level 2: Panels that are substrate for tile.
  3. Level 3: Surfaces receiving medium or heavy textured finishes or heavy wallcoverings.
  4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.

- a. Primer and its application to surfaces are specified in Section 09 91 23 "Interior Painting."
  - 5. Level 5: Where indicated on Drawings.
    - a. Primer and its application to surfaces are specified in Section 09 91 23 "Interior Painting."
  - E. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.
  - F. Cementitious Backer Units: Finish according to manufacturer's written instructions.
- 3.8 IDENTIFICATION OF INTERIOR FIRE- AND SMOKE-RATED WALLS AND PARTITIONS
- A. Markings and Identification: Refer to requirements specified in Section 09 91 23 "Interior Painting."
- 3.9 PROTECTION
- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
  - B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
  - C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
    - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
    - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

**END OF SECTION 09 29 00**



## SECTION 09 30 13

### CERAMIC TILING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Porcelain tile.
  - 2. Glazed wall tile.
  - 3. Mosaic Glass Tile.
  - 4. Waterproof membrane.
  - 5. Crack isolation membrane.
  - 6. Metal edge strips.
- B. Related Requirements:
  - 1. Section 03 30 00 – "Cast in Place Concrete" for limitations of operations.
  - 2. Section 07 92 00 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
  - 3. Section 09 29 00 "Gypsum Board" for tile backing panels.

##### 1.3 DEFINITIONS

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in its "Specifications for Installation of Ceramic Tile."
- C. Module Size: Actual tile size plus joint width indicated.
- D. Face Size: Actual tile size, excluding spacer lugs.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include statement of VOC content in g/L.

- B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
- C. Samples for Initial Selection: For grout.
- D. Samples for Verification:
  - 1. Full-size units of each type and composition of tile and for each color and finish required.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
- C. Product Certificates: For each type of product.
- D. Product Test Reports: For tile-setting and -grouting products and certified porcelain tile.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- D. Store liquid materials in unopened containers and protected from freezing.

#### 1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Source Limitations for Tile: Obtain tile of each type and color or finish from single source or producer.
  - 1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.
  - 1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.
  - 2. Obtain waterproof membrane and crack isolation membrane, except for sheet products, from manufacturer of setting and grouting materials.
- C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:
  - 1. Waterproof membrane.
  - 2. Crack isolation membrane.
  - 3. Metal edge strips.

## 2.2 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
  - 1. Provide tile complying with Standard grade requirements unless otherwise indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.
- C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
- D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.
  - 1. Where tile is indicated for installation in wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.

## 2.3 TILE PRODUCTS

- A. Porcelain Tile Type (PT-1): Unglazed porcelain tile.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following, or equal approved by Professional:
    - a. American Marazzi Tile, Inc.
    - b. American Olean Corporation.
    - c. Crossville, Inc.
    - d. Dal-Tile Corporation.
    - e. Florida Tile, Inc.
    - f. Florim USA.
    - g. Interceramic.
    - h. Iris US.
    - i. Porcelanite.
    - j. Seneca Tiles, Inc.

2. Certification: Tile certified by the Porcelain Tile Certification Agency.
3. Face Size: As indicated on Drawings on Drawings.
4. Thickness: As indicated on Finish Legend on Drawings.
5. Finish: As indicated on Finish Legend on Drawings.
6. Grout Color: As indicated on Finish Legend.
7. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:

B. Ceramic Tile Type (CT): Glazed wall tile.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following, or equal approved by Professional:
  - a. American Marazzi Tile, Inc.
  - b. American Olean Corporation.
  - c. Dal-Tile Corporation.
  - d. Jeffrey Court Inc.
  - e. Porcelanite.
  - f. Seneca Tiles, Inc.
2. Module Size: As indicated in Finish Legend on Drawings.
3. Face Size Variation: Rectified.
4. Thickness: As indicated on Finish Legend on Drawings.
5. Face: Plain with cushion edges.
6. Finish: Mat, clear glaze.
7. Grout Color: Mapei; as selected by architect from full range of colors.
8. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable. Provide shapes as follows, selected from manufacturer's standard shapes:
  - a. Internal Corners: Field-buttet square corners. For coved base and cap use angle pieces designed to fit with stretcher shapes.

C. Factory-Mounted Mosaic Glass-Tile Type: (MT-1):

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following, or equal approved by Professional:
  - a. American Marazzi Tile, Inc.
  - b. American Olean Corporation.
  - c. Dal-Tile Corporation.
  - d. Jeffrey Court Inc.
  - e. Porcelanite.
  - f. Seneca Tiles, Inc.
2. Module Size: As indicated on Finish Legend on Drawings.
3. Sizing Category: Standard.
4. Tile Color and Pattern: As indicated by manufacturer's designations.

## 2.4 WATERPROOF MEMBRANE

- A. General: Manufacturer's standard product, selected from the following, that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Chlorinated Polyethylene Sheet: Nonplasticized, chlorinated polyethylene faced on both sides with nonwoven polyester fabric.
  1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by Professional:

- a. The Noble Company; Nobleseal TS.
    - b. The Noble Company; Noble Deck.
  - 2. Nominal Thickness: 0.040 inch.
- C. PVC Sheet: PVC heat-fused on both sides to facings of nonwoven polyester.
- 1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by Professional:
    - a. Compotite Corporation; Composeal Gold.
    - b. The Noble Company; Wall Seal.
  - 2. Nominal Thickness: 0.040 inch.
- D. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and continuous fabric reinforcement.
- 1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by Professional:
    - a. H. B. Fuller Construction Products, Inc.; ProSpec B-6000 Waterproof/Crack Isolation Membrane.
    - b. Laticrete International, Inc.; 9235 Waterproof Membrane.
    - c. MAPEI Corporation; Mapelastic 400.
- E. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
- 1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by Professional:
    - a. H. B. Fuller Construction Products, Inc.; ProSpec B-6000 Waterproof/Crack Isolation Membrane.
    - b. Laticrete International, Inc.; Hydro Ban.
    - c. MAPEI Corporation; Mapelastic AquaDefense.
- F. Latex-Portland Cement Waterproof Mortar: Flexible, waterproof mortar consisting of cement-based mix and latex additive.
- 1. Products: Subject to compliance with requirements, provide MAPEI Corporation; Mapelastic 315, or equal approved by Professional.

## 2.5 CRACK ISOLATION MEMBRANE

- A. General: Manufacturer's standard product that complies with ANSI A118.12 for standard performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and fabric reinforcement.
  - 1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by Professional:
    - a. Boiardi Products Corporation, a QEP company; Elastiment 344 Reinforced Waterproofing and Anti-Fracture/Crack Suppression Membrane.

- b. Bonsal American, an Oldcastle company; B 6000 Waterproof-Crack Isolation Membrane with B 6000 Mesh.
  - c. Bostik, Inc.; Hydroment Blacktop 90210.
  - d. Custom Building Products; 9240 Waterproofing and Anti-Fracture Membrane.
  - e. Laticrete International, Inc.; Laticrete Blue 92 Anti-Fracture Membrane.
  - f. MAPEI Corporation; Mapelastc HPG with MAPEI Fiberglass Mesh.
  - g. Merkrete Systems, Parex USA, Inc.; Hydro-Guard 2000.
  - h. Southern Grouts & Mortars, Inc.; Southcrete 1100 Crack Suppression.
  - i. Summitville Tiles, Inc.; S-9000.
- C. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
- 1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by Professional:
    - a. Bostik, Inc.; Durabond D-222 Duraguard Membrane.
    - b. C-Cure; CureLastic 949.
    - c. Custom Building Products; RedGard Waterproofing and Crack Prevention Membrane.
    - d. Jamo Inc.; Waterproof.
    - e. Laticrete International, Inc.; Laticrete Hydro Ban.
    - f. MAPEI Corporation; Mapelastc AquaDefense.
    - g. Merkrete Systems, Parex USA, Inc.; Fracture Guard 5000.
    - h. Southern Grouts & Mortars, Inc.; Southcrete 1132.
    - i. TEC, H. B. Fuller Construction Products Inc.; HydraFlex - Waterproofing Crack Isolation Membrane.

## 2.6 SETTING MATERIALS

- A. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.
- 1. Reinforcing Wire Fabric: Galvanized, welded-wire fabric, 2 by 2 inches by 0.062-inch diameter; comply with ASTM A 185/A 185M and ASTM A 82/A 82M, except for minimum wire size.
  - 2. Latex Additive: Manufacturer's standard acrylic resin or styrene-butadiene-rubber water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed Portland cement and aggregate mortar bed.
- B. Modified Dry-Set Mortar (Thinset): ANSI A118.4.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by Professional:
    - a. Custom Building Products.
    - b. H.B. Fuller Construction Products Inc.; TEC.
    - c. Laticrete International, Inc.
    - d. MAPEI Corporation.
  - 2. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
  - 3. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.

## 2.7 GROUT MATERIALS

### A. Standard Cement Grout: ANSI A118.6.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by Professional:
  - a. Custom Building Products.
  - b. H.B. Fuller Construction Products, Inc.
  - c. Laticrete International, Inc.
  - d. MAPEI Corporation.

## 2.8 MISCELLANEOUS MATERIALS

### A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

### B. Metal Edge Strips: Angle or L-shaped, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; stainless-steel, ASTM A 666, 300 Series exposed-edge material.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by Professional:
  - a. Blanke Corporation.
  - b. Ceramic Tool Company, Inc.
  - c. Schluter Systems L.P.

### C. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

### D. Floor Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.

1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by Professional:
  - a. Custom Building Products Inc.; Surfaceguard Sealer.
  - b. H.B. Fuller Construction Products, Inc.; TEC; Grout Guard Plus Penetrating Grout Sealer.
  - c. Summitville Tiles, Inc.; SL-15, Invisible Seal.

## 2.9 MIXING MORTARS AND GROUT

### A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

### B. Add materials, water, and additives in accurate proportions.

- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
  - 1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
  - 2. Verify that concrete substrates for tile floors installed with adhesives or thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
    - a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
    - b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
  - 3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
  - 4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with adhesives or thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.
- C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

### 3.3 TILE INSTALLATION

- A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation



methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
  - a. Tile floors in wet areas.
  - b. Tile floors consisting of tiles 8 by 8 inches or larger.
  - c. Tile floors consisting of rib-backed tiles.
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
- F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
  1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
  2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
  3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.
- G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
  1. Glazed Wall Tile: 1/8 inch.
  2. Porcelain Tile: 1/8 inch.
  3. Mosaic Glass Tile: As recommended by manufacturer.
  4. Natural Stone Tile: 1/8 inch.
- H. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
  1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
- I. Metal Edge Strips: Install at locations indicated and where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile and no threshold is indicated.

- J. Floor Sealer: Apply floor sealer to cementitious grout joints in tile floors according to floor-sealer manufacturer's written instructions. As soon as floor sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

### 3.4 WATERPROOFING INSTALLATION

- A. Install waterproofing to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.
- B. Allow waterproofing to cure and verify by testing that it is watertight before installing tile or setting materials over it.

### 3.5 CRACK ISOLATION MEMBRANE INSTALLATION

- A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.
- B. Allow crack isolation membrane to cure before installing tile or setting materials over it.

### 3.6 ADJUSTING AND CLEANING

- A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
- B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
  - 1. Remove grout residue from tile as soon as possible.
  - 2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

### 3.7 PROTECTION

- A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

### 3.8 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

- A. Interior Floor Installations, Concrete Subfloor:

1. Ceramic Tile Installation non-wet areas; Chapel and Meditation Room: TCNA F111; and ANSI A108.1C; cement mortar bed medium set large format mortar.

- a. Ceramic Tile Type: MT-5, ST-1, ST-2.
- b. Medium set Mortar: As recommended by manufacturer.
- c. Grout: Water-cleanable epoxy grout.

B. Interior Wall Installations, Wood or Metal Studs or Furring:

1. Ceramic Tile Installation : TCNA W243; thinset mortar on gypsum board.

- a. Ceramic Tile Type: CT-1, CT-2, CT-3, CT-4, PT-1, PT-2, PT-3.
- b. Thinset Mortar: Modified dry-set mortar.
- c. Grout: Water-cleanable epoxy grout.

2. Ceramic Tile Installation Wet areas: TCNA W245; thinset mortar on glass-mat, water-resistant gypsum backer board.

- a. Ceramic Tile Type: Ceramic Tile Type: CT-1, CT-2, CT-3, CT-4, PT-1, PT-2, PT-3.
- b. Thinset Mortar: Modified dry-set mortar.
- c. Grout: Water-cleanable epoxy grout.

3. Glass Tile Installation mosaic tile on wet walls: TCNA W245 or TCNA W248; thinset mortar on glass-mat, water-resistant gypsum backer board.

- a. Glass Tile Type: MT-1, MT-2, MT-3, MT-4.
- b. Thinset Mortar or Mastic: As recommended by manufacturer.
- c. Grout: High-performance unsanded grout.

END OF SECTION 09 30 13

## SECTION 09 51 13

### ACOUSTICAL PANEL CEILINGS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section includes acoustical panels and exposed suspension systems for ceilings.
- B. Related Requirements:
  - 1. Section 07 92 19 "Acoustical Joint Sealants" for sealing joints where edge moldings meet adjacent construction.
  - 2. Section 09 51 33 "Acoustical Metal Pan Ceilings."

##### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified.
- C. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
  - 1. Acoustical Panel: Set of 6-inch- square Samples of each type, color, pattern, and texture.
  - 2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch- long Samples of each type, finish, and color.

##### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.

- B. Product Test Reports: For each acoustical panel ceiling, for tests performed by a qualified testing agency.
- C. Evaluation Reports: For each acoustical panel ceiling suspension system and anchor and fastener type, from ICC-ES.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes to include in maintenance manuals.

#### 1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to NVLAP.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

#### 1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
  - 1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

### **PART 2 - PRODUCTS**

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Acoustical ceiling shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
  - 2. Smoke-Developed Index: 50 or less.

- C. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

## 2.2 ACOUSTICAL PANELS, GENERAL

- A. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system from single source from single manufacturer.
- B. Glass-Fiber-Based Panels: Made with binder containing no urea formaldehyde.
- C. Acoustical Panel Standard: Comply with ASTM E 1264.
  - 1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface according to ASTM E 795.
- D. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.

## 2.3 ACOUSTICAL PANELS Retain this article with "Acoustical Panels, General" Article.

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated in Finish Material Legend or comparable product by one of the following, or equal approved by Professional:
  - 1. Armstrong World Industries, Inc.
  - 2. CertainTeed Corp.
  - 3. USG Interiors, Inc.; Subsidiary of USG Corporation.
- B. Classification: Provide panels complying with ASTM E 1264 for type, form, and pattern as follows:
  - 1. Type and Form: Type III, mineral base with painted finish; Form 2, water felted.
  - 2. Type and Form: Type IV, mineral base with membrane-faced overlay; Form 2, water felted; with vinyl overlay on face.
  - 3. Type and Form: As indicated in Finish Material Legend..
  - 4. Pattern: As indicated by manufacturer's designation.
- C. Color: As indicated on Drawings.
- D. LR: Not less than 0.80.
- E. NRC: Not less than 0.70.
- F. CAC: Not less than 35.
- G. Edge/Joint Detail: Square.
- H. Thickness: As indicated on Drawings.
- I. Modular Size: As indicated on Drawings.

- J. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

## 2.4 METAL SUSPENSION SYSTEMS, GENERAL

- A. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.
- B. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
  - 1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
    - a. Type: Postinstalled expansion or Postinstalled bonded anchors.
    - b. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
  - 2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.
- C. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
  - 1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
  - 2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch-diameter wire.
- D. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.
- E. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.
- F. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical panels in place.
- G. Hold-Down Clips: Where indicated, provide manufacturer's standard hold-down clips spaced 24 inches o.c. on all cross tees.

## 2.5 METAL SUSPENSION SYSTEM

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries, Inc.; Prelude 15/16 Inch Exposed Tee System and/or Armstrong World Industries, Inc.; Suprafine 9/16 Inch Exposed Tee System or comparable product by one of the following, or equal approved by Professional:
1. Armstrong World Industries, Inc.
  2. CertainTeed Corp.
  3. USG Interiors, Inc.; Subsidiary of USG Corporation.
- B. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 coating designation; with prefinished 15/16-inch- wide metal caps on flanges.
1. Structural Classification: Heavy-duty system.
  2. End Condition of Cross Runners: Override (stepped) or butt-edge type.
  3. Face Design: Flat, flush.
  4. Cap Material: Aluminum cold-rolled sheet.
  5. Cap Finish: Painted white.
- C. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 coating designation; with prefinished 9/16-inch- wide metal caps on flanges.
1. Structural Classification: Heavy-duty system.
  2. End Condition of Cross Runners: Override (stepped) or butt-edge type.
  3. Face Design: Flat, flush.
  4. Cap Material: Aluminum cold-rolled sheet.
  5. Cap Finish: Painted white.

## 2.6 METAL EDGE MOLDINGS AND TRIM

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following, or equal approved by Professional:
1. Armstrong World Industries, Inc.
  2. CertainTeed Corp.
  3. Chicago Metallic Corporation.
  4. Fry Reglet Corporation.
  5. Gordon, Inc.
  6. USG Interiors, Inc.; Subsidiary of USG Corporation.
- B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
1. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.



2. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
  3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
- C. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements and the following:
1. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 for Alloy and Temper 6063-T5.
  2. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of 1.5 mils. Comply with ASTM C 635/C 635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 PREPARATION**

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

#### **3.3 INSTALLATION**

- A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
- B. Suspend ceiling hangers from building's structural members and as follows:
  1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
  2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
  4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
  5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
  6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
  7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
  8. Do not attach hangers to steel deck tabs.
  9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
  10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
  11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of three full turns (360 degrees each) within a 3-inch length. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Apply acoustical sealant as specified in Section 07 92 19 "Acoustical Joint Sealants" in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
  2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
  3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
1. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
  2. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
  3. For reveal-edged panels on suspension-system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.

4. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
5. Install **[hold-down]** **[impact]** clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions unless otherwise indicated.

#### 3.4 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

**END OF SECTION 09 51 13**

## SECTION 09 65 16

### RESILIENT FLOORING AND ACCESSORIES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:

1. Solid vinyl floor tile
2. Luxury vinyl tile
3. Vinyl sheet flooring.
4. Vinyl sheet flooring with backing.
5. Resilient base.
6. Resilient molding accessories.

- B. Related Requirements

1. Section 03 30 00 – "Cast in Place Concrete" for limitations of operations.
2. Section 05 50 00 – "Metal Fabrications": Supplementary supports for overhead track assembly, not specified in this section

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Include VOC content for adhesives, chemical bonding compound and sealants in g/L.

- B. Shop Drawings: For each type of resilient sheet flooring.

1. Include flooring layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
2. Show details of special patterns.

- C. Samples:

1. Full-size units of each color, texture, and pattern of floor tile required.
2. Minimum 6-by-9-inch section for each color and texture of sheet flooring required.
  - a. For heat-welding bead, manufacturer's standard-size Samples, but not less than 9 inches long, of each color required.

3. Welded-Seam Samples: For seamless-installation technique indicated and for each resilient sheet flooring product, color, and pattern required; with seam running lengthwise and in center of 6-by-9-inch Sample applied to a rigid backing and prepared by Installer for this Project.
  4. Minimum 12-inch long section of each resilient base or accessory product color or pattern required.
- D. Product Schedule: For resilient flooring and resilient base and accessories. Use same designations indicated on Drawings.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of resilient flooring and accessory to include in maintenance manuals.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for resilient sheet flooring installation and seaming method indicated.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient flooring and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store rolls upright.

#### 1.7 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 85 deg F, in spaces to receive resilient flooring during the following periods:
1. 48 hours before installation.
  2. During installation.
  3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Close spaces to traffic during resilient flooring installation.
- D. Close spaces to traffic for 48 hours after resilient flooring installation.
- E. Install resilient flooring after other finishing operations, including painting, have been completed.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient floor tile and resilient sheet flooring, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
  - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

### 2.2 SOLID VINYL FLOOR TILE (SVT)

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following, or equal approved by Professional:
  - 1. Armstrong World Industries, Inc.
  - 2. Forbo Industries, Inc.
  - 3. Gerflor.
  - 4. Johnsonite; A Tarkett Company.
  - 5. Mannington Mills, Inc.
  - 6. Polyflor, Ltd., Distributed by Gerbert Limited.
- B. Tile Standard: ASTM F 1700.
  - 1. Class: Class III, Printed Film Vinyl Tile.
  - 2. Type A, Smooth Surface and Type B, Embossed Surface.
- C. Thickness: As indicated on the Finish Material Legend.
- D. Size: As indicated on the Finish Material Legend.
- E. Color: As indicated in Finish Material Legend on Drawings.

### 2.3 LUXURY VINYL FLOOR TILE (LVT)

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following, or equal approved by the Professional:
  - 1. Armstrong World Industries, Inc.
  - 2. Forbo Industries, Inc.
  - 3. Gerflor.
  - 4. Johnsonite; A Tarkett Company.
  - 5. Mannington Mills, Inc.
  - 6. Polyflor, Ltd., Distributed by Gerbert Limited.
- B. Tile Standard: ASTM F 1700.
  - 1. Class: Class III, Printed Film Vinyl Tile.
  - 2. Type B, Embossed Surface.
- C. Thickness: 1/8 inch
- D. Wear Layer Thickness: 0.020 inch

- E. Size: As indicated in Finish Legend on Drawings.
- F. Color: As indicated in Finish Legend on Drawings.

#### 2.4 UNBACKED VINYL SHEET FLOORING (RSF)

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following, or equal approved by the Professional:
  - 1. Armstrong World Industries, Inc.
  - 2. Forbo Industries, Inc.
  - 3. Gerflor.
  - 4. Johnsonite; A Tarkett Company.
  - 5. Mannington Mills, Inc.
  - 6. Polyflor, Ltd., Distributed by Gerbert Limited.
- B. Product Standard: ASTM F 1913.
- C. Thickness: 0.080 inch.
- D. Wearing Surface: Smooth.
- E. Sheet Width: As standard with manufacturer.
- F. Seamless-Installation Method: Heat welded.
- G. Colors: As indicated in Finish Material Legend on Drawings.

#### 2.5 VINYL SHEET FLOORING WITH BACKING (VSF)

- A. Products: Subject to compliance with requirements, provide products indicated in Finish Legend on Drawings or approved substitution by one of the following, or equal approved by the Professional:
  - 1. Mannington Mills, Inc.
  - 2. Mohawk
  - 3. Interface
- B. Product Standard: ASTM F 1303.
  - 1. Type (Binder Content): Type I, minimum binder content of 90 percent.
  - 2. Wear-Layer Thickness: Grade 1.
  - 3. Overall Thickness: 0.25 inch.
  - 4. Backing: Vulcanized composition rubber.
- C. Wearing Surface: Smooth.
- D. Sheet Width: As standard with manufacturer.
- E. Seamless-Installation Method: Heat welded.
- F. Colors: As indicated in Finish Material Legend on Drawings.

## 2.6 THERMOPLASTIC RUBBER BASE (B-1)

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following, or equal approved by the Professional:
  - 1. Armstrong World Industries, Inc.
  - 2. Burke Mercer Flooring Products, Division of Burke Industries Inc.
  - 3. Flexco.
  - 4. Johnsonite; A Tarkett Company.
  - 5. Roppe Corporation, USA.
- B. Product Standard: ASTM F 1861, Type TP (rubber, thermoplastic), Group I (solid, homogenous).
- C. Thickness: 0.125 inch.
- D. Height: As indicated in Finish Legend on Drawings.
- E. Lengths: Coils in manufacturer's standard length.
- F. Color: As indicated in Finish Schedule on Drawings.
- G. Outside Corners: Preformed.
- H. Inside Corners: Job formed.

## 2.7 THERMOPLASTIC RUBBER BASE (B-2)

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following, or equal approved by the Professional:
  - 1. Armstrong World Industries, Inc.
  - 2. Burke Mercer Flooring Products, Division of Burke Industries Inc.
  - 3. Flexco.
  - 4. Johnsonite; A Tarkett Company.
  - 5. Roppe Corporation, USA.
- B. Product Standard: ASTM F 1861, Type TP (rubber, thermoplastic).
  - 1. Group: I (solid, homogeneous).
  - 2. Style: As indicated on Drawings.
- C. Thickness: As indicated in Finish Material Legend on Drawings.
- D. Height: As indicated on Drawings.
- E. Lengths: 8 foot.
- F. Color: As indicated in Finish Legend on Drawings.
- G. Outside Corners: Mitered.
- H. Inside Corners: Mitered.



## 2.8 RUBBER STAIR ACCESSORIES

- A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.
  - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide products by Johnsonite; a Tarkett company or comparable products by one of the following, or equal approved by the Professional:
  - 1. Armstrong World Industries.
  - 2. Roppe Corporation, USA.
- C. Stair Treads: ASTM F2169.
  - 1. Type: TS (rubber, vulcanized thermoset).
  - 2. Class: 1 (smooth, flat).
  - 3. Group: 1 (embedded abrasive strips).
  - 4. Nosing Style: Square, adjustable to cover angles between 60 and 90 degrees.
  - 5. Nosing Height: 1-1/2 inches.
  - 6. Thickness: 1/4 inch and tapered to back edge.
  - 7. Size: Lengths and depths to fit each stair tread in one piece.
  - 8. Integral Risers: Smooth, flat; in height that fully covers substrate.
- D. Landing Tile: Matching treads; produced by same manufacturer as treads and recommended by manufacturer for installation with treads.
- E. Locations: Provide rubber stair accessories in areas indicated.
- F. Colors and Patterns: As indicated in Finish Material Legend on Drawings.

## 2.9 RUBBER MOLDING ACCESSORIES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following, or equal approved by the Professional:
  - 1. Roppe Corporation, USA.
  - 2. VPI, LLC, Floor Products Division.
- B. Description: transition strips.
- C. Profile and Dimensions: As indicated.
- D. Locations: As indicated.
- E. Color: As indicated in Finish Material Legend on Drawings.

## 2.10 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient flooring manufacturer for applications indicated.

- B. Adhesives: Water-resistant type recommended by flooring and adhesive manufacturers to suit resilient flooring and substrate conditions indicated.
  - 1. Adhesives shall have a VOC content of 60 g/L or less.
  - 2. Adhesives shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
- C. Seamless-Installation Accessories:
  - 1. Cold-Welding Bead: Manufacturer's solid-strand product for cold welding seams.
    - a. Color: Match flooring.
- D. Integral-Flash-Cove-Base Accessories:
  - 1. Cove Strip: 1-inch radius provided or approved by resilient sheet flooring manufacturer.
  - 2. Cap Strip: Square rubber cap provided or approved by resilient sheet flooring manufacturer.
- E. Metal Edges Strips: Extruded aluminum with mill finish of width shown, of height required to protect exposed edges of flooring, and in maximum available lengths to minimize running joints.
- F. Floor Polish: Provide protective, liquid floor-polish products recommended by resilient flooring manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
  - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient sheet flooring.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
  - 1. Installation of resilient flooring products indicates acceptance of surfaces and conditions.

### 3.2 PREPARATION

- A. Prepare substrates according to resilient flooring manufacturer's written instructions to ensure adhesion of resilient flooring.
- B. Concrete Substrates: Prepare according to ASTM F 710.
  - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.

2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by resilient flooring manufacturer. Do not use solvents.
  3. Alkalinity and Adhesion Testing: Perform tests recommended by resilient flooring manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
  4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft., and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
    - a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
    - b. Relative Humidity Test: Using in-situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install resilient flooring products until materials are the same temperature as space where they are to be installed.
1. At least 48 hours in advance of installation, move flooring and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

### 3.3 RESILIENT FLOORING INSTALLATION - GENERAL

- A. Comply with manufacturer's written instructions for installing resilient flooring.
- B. Scribe and cut resilient flooring to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- C. Extend resilient flooring into toe spaces, door reveals, closets, and similar openings.
- D. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on resilient flooring as marked on substrates. Use chalk or other nonpermanent marking device.
- E. Install resilient flooring on covers for telephone and electrical ducts and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of flooring installed on covers and adjoining flooring. Tightly adhere flooring edges to substrates that abut covers and to cover perimeters.
- F. Adhere resilient flooring to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

### 3.4 FLOOR TILE INSTALLATION

- A. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
  - 1. Where patterns are indicated on drawings, lay tiles in pattern shown on Floor Finish Drawings.
- B. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
  - 1. Where patterns are indicated on drawings, lay tiles in pattern shown on Floor Finish Drawings.

### 3.5 RESILIENT SHEET FLOORING INSTALLATION

- A. Unroll resilient sheet flooring and allow it to stabilize before cutting and fitting.
- B. Lay out resilient sheet flooring as follows:
  - 1. Maintain uniformity of flooring direction.
  - 2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches away from parallel joints in flooring substrates.
  - 3. Match edges of flooring for color shading at seams.
  - 4. Avoid cross seams.
- C. Seamless Installation:
  - 1. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and heat weld with welding bead to fuse sections permanently into a seamless flooring installation. Prepare, weld, and finish seams to produce surfaces flush with adjoining flooring surfaces.
- D. Integral-Flash-Cove Base: Cove resilient sheet flooring to dimension indicated up vertical surfaces. Support flooring at horizontal and vertical junction with cove strip. Ensure that sheet flooring material is not stretched to span unsupported above cove strip. Butt at top against cap strip.
  - 1. Form external corners using a butterfly piece or v-plug of flooring material. Heat material to shape needed.
  - 2. Cut inside corners at a 45-degree angle on the wall.

### 3.6 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Seal gaps between wall and top of base with clear sealant.
- H. Preformed Corners: Install preformed corners before installing straight pieces.
- I. Job-Formed Corners:
  - 1. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
    - a. Miter or cope corners to minimize open joints.
    - b. Provide clear sealant at corner joints.
- J. Mitered Corners: Miter in accordance with manufacturer's written instructions.

### 3.7 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

### 3.8 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient product installation:
  - 1. Remove adhesive and other blemishes from surfaces.
  - 2. Sweep and vacuum surfaces thoroughly.
  - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover resilient flooring until Substantial Completion.

END OF SECTION 09 65 10

**SECTION 09 67 23**  
**RESINOUS FLOORING**

**PART 1 - GENERAL**

**1.1 STIPULATIONS**

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

**1.2 SUMMARY**

- A. Section includes resinous flooring systems.
- B. Related Sections:
  - 1. Section 03 30 00 – "Cast in Place Concrete" for limitations of operations.
  - 2. Section 07 92 00 "Joint Sealants" for sealants installed in joints in resinous flooring systems.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product. Include manufacturer's technical data, application instructions, and recommendations for each resinous flooring component required.
  - 1. Include documentation of VOC levels in g/L.
- B. Samples for Verification: For each resinous flooring system required, 6 inches square, applied to a rigid backing by Installer for this Project.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.
- B. Material Certificates: For each resinous flooring component, from manufacturer.
- C. Material Test Reports: For each resinous flooring system, by a qualified testing agency.

**1.5 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For resinous flooring to include in maintenance manuals.

## 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

## 1.8 FIELD CONDITIONS

- A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.
  - 1. Maintain material and substrate temperature between 65 and 85 deg F (18 and 30 deg C) during resinous flooring application and for not less than 24 hours after application.
- B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.
- C. Close spaces to traffic during resinous flooring application and for 24 hours after application unless manufacturer recommends a longer period.
- D. Concrete substrate shall be properly cured. A vapor barrier must be present for concrete subfloors on or below grade. Otherwise, an osmotic pressure resistant grout must be installed prior to the resinous flooring.

## 1.9 WARRANTY

- A. Manufacturer shall furnish a single, written warranty covering both material and workmanship for a period of (1) full years from date of installation, or provide a joint and several warranty signed on a single document by material manufacturer and applicator jointly and severally warranting the materials and workmanship for a period of (1) full year from date of installation. A sample warranty letter must be included with bid package or bid may be disqualified.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Flammability: Self-extinguishing according to ASTM D 635.

## 2.2 MANUFACTURERS

- A. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Obtain secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from manufacturer recommended in writing by manufacturer of primary materials.

## 2.3 RESINOUS FLOORING (RES-1)

- A. Resinous Flooring System: Abrasion-, impact-, and chemical-resistant, and resin-based monolithic floor surfacing designed to produce a seamless floor and integral cove base.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Stonhard, Inc.; Stonshield SLT, or comparable product by one of the following, or equal approved by the Professional:
    - a. Sherwin-Williams Company; General Polymers.
    - b. Tnemec Company.
    - c. Valspar Flooring.
- B. System Characteristics:
  - 1. Color and Pattern: As indicated in Finish Schedule on Drawings.
  - 2. Wearing Surface: Medium Texture.
  - 3. Integral Cove Base
  - 4. Overall System Thickness: 3/16 inch
- C. System Components: Manufacturer's standard components that are compatible with each other and as follows:
  - 1. Mortar:
    - a. Material design basis: Stonclad UT
    - b. Resin: Urethane.
    - c. Formulation Description: (4) four-component, 100 percent solids.
    - d. Application Method: Screed, Trowel.
      - 1) Thickness of Coats: 3/16".
      - 2) Number of Coats: One.
      - 3) Broadcast texture into wet mortar base.
    - e. Aggregates: Pigmented Blended aggregate.
  - 2. Top coat:
    - a. Material design basis: Stonseal UT7
    - b. Resin: Urethane.
    - c. Formulation Description: (2) two-component, 100 percent solids.
    - d. Type: pigmented.
    - e. Finish: standard.
    - f. Number of Coats: One.
- D. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:



1. Compressive Strength: 7,700 psi after 7 days per ASTM C 579.
2. Tensile Strength: 1,000 psi per ASTM C 307.
3. Flexural Strength: 2,400 psi per ASTM C 580.
4. Water Absorption: < 1% per ASTM C 413.
5. Impact Resistance: > 160 in. lbs. per ASTM D 2794.
6. Flammability: Class 1 per ASTM E-648.
7. Hardness: .80 to .84, Shore D per ASTM D 2240.
8. Flexural Modulus of Elasticity: 2.6x10<sup>6</sup> psi per ASTM C-580
9. Thermal Coefficient of Linear Expansion: 1.1x10<sup>-5</sup> in./in.°F per ASTM C-531

## 2.4 RESINOUS FLOORING (RES-2)

- A. Resinous Flooring System: Abrasion-, impact-, and chemical-resistant, and resin-based monolithic floor surfacing designed to produce a seamless floor and integral cove base.
  1. Basis-of-Design Product: Subject to compliance with requirements, provide Sherwin Williams Co; General Polymers: Epo-Flex MER II, or comparable product by one of the following, or equal approved by the Professional:
    - a. Sherwin-Williams Company; General Polymers.
    - b. Tnemec Company.
    - c. Valspar Flooring.
- B. System Characteristics:
  1. Color and Pattern: As indicated in Finish Schedule on Drawings.
  2. Wearing Surface: Medium Texture.
  3. Integral Cove Base
  4. Overall System Thickness: 3/32 inch
- C. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:
  1. Tensile Strength: ASTM D412, 1700 psi.
  2. Waterproofness: No transmission subject to test at 50 lbs. per inch water pressure for 60 mins.
  3. Elongation: 80%
  4. Hardness: ASTM D 2240, Shore D, 50/40
  5. Abrasion Resistance: ASTM D, 100mgs lost

## 2.5 ACCESSORY MATERIALS

- A. Primer: Type recommended by resinous flooring manufacturer for substrate and resinous flooring system indicated.
- B. Waterproofing Membrane: Type recommended by resinous flooring manufacturer for substrate and resinous flooring system indicated.
- C. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.
- D. Metal Cap for Integral Cove Base: Square metal cap approved by flooring manufacturer.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry substrate for resinous flooring application.
- B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.
  - 1. Mechanically prepare substrates as follows:
    - a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
    - b. Comply with ASTM C 811 requirements, unless manufacturer's written instructions are more stringent.
  - 2. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written instructions.
  - 3. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.
    - a. Perform in situ probe test, ASTM F 2170. Proceed with application only after substrates do not exceed a maximum potential equilibrium relative humidity of 85 percent.
    - b. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with application of resinous flooring only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. of slab area in 24 hours.
    - c. Perform additional moisture tests recommended by manufacturer. Proceed with application only after substrates pass testing.
  - 4. Alkalinity and Adhesion Testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.
- C. Patching and Filling: Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.
  - 1. Control Joint Treatment: Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written instructions.
- D. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.

### 3.2 APPLICATION

- A. Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.

1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
  2. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
  3. Expansion and Isolation Joint Treatment: At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.
- B. Primer: Apply primer over prepared substrate at manufacturer's recommended spreading rate.
- C. Integral Cove Base: Apply cove base mix to wall surfaces before applying flooring. Apply according to manufacturer's written instructions and details, including those for taping, mixing, priming, troweling, sanding, and top coating of cove base. Round internal and external corners.
1. Integral Cove Base: 6 inches high.
- D. Self-Leveling Body Coats: Apply self-leveling slurry body coats in thickness indicated for flooring system.
1. Aggregates: Broadcast aggregates at rate recommended by manufacturer and, after resin is cured, remove excess aggregates to provide surface texture indicated.
- E. Grout Coat: Apply grout coat, of type recommended by resinous flooring manufacturer, to fill voids in surface of final body coat.
- F. Topcoats: Apply topcoats in number indicated for flooring system and at spreading rates recommended in writing by manufacturer and to produce wearing surface indicated.

### 3.3 FIELD QUALITY CONTROL

#### A. Manufacturer's Field Services

1. Manufacturer shall provide periodic field observation services, at a minimum, as follows:
  - a. Upon completion of substrate preparation and preparatory work of other trades.
  - b. At regular intervals during the installation process to qualify the installation for the specified warranty.
  - c. After completion of flooring installation, review the work and the installer's documentation to verify materials and installation comply with manufacturer's warranty requirements.
2. Issue written reports promptly upon completion of each field visit. Submit reports with the executed warranties.

#### B. Floor Flatness: For all floors not indicated to slope to drain, inspect finished floor for flatness.

1. Finished floors shall be at least as flat as the substrate on which they are laid.
2. Correct any deviation greater than 1/8-inch in 12-feet according to the system manufacturer's written recommendations.]

### 3.4 FIELD QUALITY CONTROL

- #### A. Core Sampling: At the direction of Owner and at locations designated by Owner, take one core sample per 1000 sq. ft. of resinous flooring, or portion of, to verify thickness. For each sample

that fails to comply with requirements, take two additional samples. Repair damage caused by coring. Correct deficiencies in installed flooring as indicated by testing.

### 3.5 PROTECTION

- A. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

END OF SECTION 09 67 23

## SECTION 09 68 10

### CARPETING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section includes:

- 1. Modular carpet tile.

- B. Related Requirements:

- 1. Section 03 30 00 "Cast in Place Concrete" for limitations of operations.
- 2. Section 09 65 10 "Resilient Flooring and Accessories" for resilient wall base and accessories installed with carpet tile.

##### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

- 1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.
- 2. Review methods and procedures related to carpet tile installation including, but not limited to, the following:
  - a. Review delivery, storage, and handling procedures.
  - b. Review ambient conditions and ventilation procedures.
  - c. Review subfloor preparation procedures.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- 1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
- 2. Include manufacturer's written installation recommendations for each type of substrate.
- 3. For installation adhesive, include printed statement of VOC content in g/L.

- B. Shop Drawings: For carpet tile installation, plans showing the following:
1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
  2. Carpet tile type, color, and dye lot.
  3. Locations where dye lot changes occur.
  4. Seam locations, types, and methods.
  5. Type of subfloor.
  6. Type of installation.
  7. Pattern of installation.
  8. Pattern type, location, and direction.
  9. Pattern type, repeat size, location, direction, and starting point.
  10. Pile direction.
  11. Type, color, and location of insets and borders.
  12. Type, color, and location of edge, transition, and other accessory strips.
  13. Transition details to other flooring materials.
- C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
1. Carpet Tile: Full-size Sample.
- D. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.
- C. Sample Warranty: For special warranty.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
  1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
  2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

#### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI's "CRI Carpet Installation Standard."

## 1.9 FIELD CONDITIONS

- A. Comply with CRI's "CRI Carpet Installation Standard" for temperature, humidity, and ventilation limitations.
- B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.
- C. Do not install carpet tile over concrete slabs until slabs are sufficiently dry to bond with adhesive, and have pH range recommended by carpet tile manufacturer.

## 1.10 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
  - 1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
  - 2. Failures include, but are not limited to, the following:
    - a. More than 10 percent edge raveling, snags, and runs.
    - b. Dimensional instability.
    - c. Excess static discharge.
    - d. Loss of tuft-bind strength.
    - e. Loss of face fiber.
    - f. Delamination.
  - 3. Warranty Period: 10 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 CARPET TILE (CPT-1)

- A. Products: Subject to compliance with requirements, provide products indicated in Finish Schedule on Drawings or approved substitution by one of the following, or equal approved by Professional:
  - 1. Mannington Mills, Inc.
  - 2. Mohawk
  - 3. Interface
- B. Primary Backing/Backcoating: Manufacturer's standard composite materials.
- C. Size: As indicated on the Finish Legend on the Drawings.
- D. Applied Treatments:
  - 1. Soil-Resistance Treatment: Manufacturer's standard treatment.
  - 2. Antimicrobial Treatment: Manufacturer's standard treatment that protects carpet tiles as follows:

- a. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.

E. Performance Characteristics:

- 1. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm according to NFPA 253.

## 2.2 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.
  - 1. Adhesives shall have a VOC content of 50 g/L or less.
- C. Metal Edge/Transition Strips: Extruded aluminum with mill finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.
- B. Examine carpet tile for type, color, pattern, and potential defects.
- C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 03 30 00 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. General: Comply with CRI's "Carpet Installation Standards" and with carpet tile manufacturer's written installation instructions for preparing substrates.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.



- C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

### 3.3 CARPET TILE INSTALLATION

- A. General: Comply with CRI's "CRI Carpet Installation Standard," Section 18, "Modular Carpet" and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: As recommended in writing by carpet tile manufacturer.
- C. Maintain dye-lot integrity. Do not mix dye lots in same area.
- D. Maintain pile-direction patterns indicated on Drawings.
- E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.
- H. Install pattern parallel to walls and borders.

### 3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
  - 1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.
  - 2. Remove yarns that protrude from carpet tile surface.
  - 3. Vacuum carpet tile using commercial machine with face-beater element.
- B. Protect installed carpet tile to comply with CRI's "Carpet Installation Standard."
- C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 09 68 10

## **SECTION 097200**

### **WALL COVERINGS**

#### **PART 1 - GENERAL**

##### **1.1 STIPULATIONS**

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Vinyl wall covering.
  - 2. Woven polyethylene wall covering.

##### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include data on physical characteristics, durability, fade resistance, and fire-test-response characteristics.
- B. Shop Drawings: Show location and extent of each wall-covering type. Indicate pattern placement seams and termination points.
- C. Samples for Verification: For each type of wall covering and for each color, pattern, texture, and finish specified, full width by 36 inches long in size.
  - 1. Wall-Covering Sample: From same production run to be used for the Work, with specified treatments applied.
    - a. Show complete pattern repeat.
    - b. Mark top and face of fabric.
- D. Product Schedule: For wall coverings. Use same designations indicated on Drawings.

##### **1.4 INFORMATIONAL SUBMITTALS**

- A. Product Test Reports: For each wall covering, for tests performed by a qualified testing agency.

##### **1.5 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For wall coverings to include in maintenance manuals.

## 1.6 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install wall coverings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and HVAC system is operating and maintaining ambient temperature and humidity conditions at levels intended for occupants after Project completion during the remainder of the construction period.
- B. Lighting: Do not install wall covering until lighting that matches conditions intended for occupants after Project completion is provided on the surfaces to receive wall covering.
- C. Ventilation: Provide continuous ventilation during installation and for not less than the time recommended by wall-covering manufacturer for full drying or curing.

## PART 2 - PRODUCTS

### 2.1 VINYL WALL COVERING

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated in Finish Legend on the Drawings or comparable product by one of the following, or equal approved by Professional:
  - 1. Arc-Com Fabrics, Inc.
  - 2. DesignTex Inc.; a Steelcase company.
  - 3. Eykon; Wallcovering Source.
  - 4. F. Schumacher & Co.
  - 5. Gilford.
  - 6. Knoll, Inc.
  - 7. Versa.
  - 8. Vescom America.
  - 9. Warner Company (The).
  - 10. York Wallcoverings.
- B. Description: Provide vinyl products in rolls from same production run and complying with the following:
  - 1. ASTM E84 Adhered as stocked: Class: FS:15 SD:15
  - 2. ASTM F793/F793M for peelable wall coverings.
    - a. Category: V, Type II, Commercial Serviceability (Vinyl Coated).
- C. Total Weight: 18.0 ounce, excluding coatings.
- D. Width: 52-inches.
- E. Backing: Polyester cellulose fabric.
- F. Mildew Resistance: Rating of zero or 1 when tested in accordance with ASTM G21.
- G. Colors, Textures, and Patterns: Match Architect's samples.

## 2.2 ACCESSORIES

- A. Adhesive: Mildew-resistant, nonstaining adhesive, for use with specific wall covering and substrate application indicated and as recommended in writing by wall-covering manufacturer.
- B. Primer/Sealer: Mildew resistant, as recommended in writing by primer/sealer and wall-covering manufacturers for intended substrate.
- C. Metal Primer: Interior ferrous metal primer complying with requirements in Section 099123 "Interior Painting" and recommended in writing by primer and wall-covering manufacturers for intended substrate.
- D. Seam Tape: As recommended in writing by wall-covering manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation surfaces being true in plane and vertical and horizontal alignment, maximum moisture content, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances that could impair bond of wall covering, including dirt, oil, grease, mold, and mildew.
- C. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.
  - 1. Moisture Content: Maximum of 5 percent on new plaster, concrete, and concrete masonry units when tested with an electronic moisture meter.
  - 2. Plaster: Allow plaster to cure for at least 90 days. Neutralize areas of high alkalinity. Apply primer/sealer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
  - 3. Metals: If not factory primed, clean and apply metal primer as recommended in writing by metal-primer manufacturer and wall-covering manufacturer.
  - 4. Gypsum Board: Apply primer/sealer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
  - 5. Painted Surfaces:
    - a. Check for pigment bleeding. Apply primer/sealer to areas susceptible to pigment bleeding as recommended in writing by primer/sealer manufacturer.
    - b. Sand gloss, semigloss, and eggshell finishes with fine sandpaper.
- D. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

- E. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.

### 3.3 INSTALLATION OF WALL LINER

- A. Install wall liner, without gaps or overlaps. Form smooth wrinkle-free surface for finished installation. Do not begin wall-covering installation until wall liner has dried.

### 3.4 INSTALLATION OF WALL COVERING

- A. Comply with wall-covering manufacturers' written installation instructions applicable to products and applications indicated.
- B. Cut wall-covering strips in roll number sequence. Change the roll numbers at partition breaks and corners.
- C. Install strips in same order as cut from roll.
  - 1. For solid-color, even-texture, or random-match wall coverings, reverse every other strip.
- D. Install wall covering without lifted or curling edges and without visible shrinkage.
- E. Match pattern above the finish floor.
- F. Install seams vertical and plumb at least 6 inches from outside corners and 3 inches from inside corners unless a change of pattern or color exists at corner. Horizontal seams are not permitted.
- G. Trim edges and seams for color uniformity, pattern match, and tight closure. Butt seams without overlaps or gaps between strips.
- H. Fully bond wall covering to substrate. Remove air bubbles, wrinkles, blisters, and other defects.

### 3.5 FIELD FINISHING OF WOOD-VENEER WALL COVERINGS

- A. Apply specified finish system according to coating manufacturer's written instructions to produce finish that is consistent in color and gloss and matches approved Samples.
- B. Apply no fewer than three finish coats.

### 3.6 CLEANING

- A. Remove excess adhesive at seams, perimeter edges, and adjacent surfaces.
- B. Use cleaning methods recommended in writing by wall-covering manufacturer.
- C. Replace strips that cannot be cleaned.
- D. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

END OF SECTION 09 72 00

**SECTION 09 91 13**  
**EXTERIOR PAINTING**

**PART 1 - GENERAL**

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

- A. Section includes surface preparation and the application of paint systems on exterior substrates.
1. Galvanized metal (railings, exposed lintels, etc.).
  2. Fiberglass and plastic trim fabrications.
  3. Exterior gypsum board.
  4. Fiber-cement siding and trim.
- B. Related Requirements:
1. Division 05 Sections for shop priming of metal substrates with primers specified in this Section.
  2. Section 09 91 23 "Interior Painting" for surface preparation and the application of paint systems on interior substrates.
  3. Section 09 93 00 "Staining and Transparent Finishing" for surface preparation and the application of wood stains and transparent finishes on exterior wood substrates.
  4. Section 09 96 00 "High-Performance Coatings" for special-use coatings.

1.3 DEFINITIONS

- A. Gloss Level 1 (Flat): Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. Gloss Level 3 (Eggshell): 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. Gloss Level 4 (Satin): 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- D. Gloss Level 5 (Semi-Gloss): 35 to 70 units at 60 degrees, according to ASTM D 523.
- E. Gloss Level 6 (Gloss): 70 to 85 units at 60 degrees, according to ASTM D 523.
- F. Gloss Level 7 (High Gloss): More than 85 units at 60 degrees, according to ASTM D 523.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Samples: For each type of paint system and each color and gloss of topcoat.
- C. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
  - 1. Submit Samples on rigid backing, 8 inches square.
  - 2. Step coats on Samples to show each coat required for system.
  - 3. Label each coat of each Sample.
  - 4. Label each Sample for location and application area.
- D. Product List: For each product indicated, include the following:
  - 1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
  - 2. Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
  - 3. VOC content in g/L.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
  - 1. Maintain containers in clean condition, free of foreign materials and residue.
  - 2. Remove rags and waste from storage areas daily.

#### 1.6 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints and coatings under environmental conditions outside manufacturer's absolute limits. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

### **PART 2 - PRODUCTS**

#### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles for the paint category indicated or comparable product by one of by one of the following, or equal approved by Professional:
  - 1. Benjamin Moore & Co.
  - 2. Duron, Inc.
  - 3. ICI Paints.
  - 4. M.A.B. Paints.
  - 5. PPG Architectural Finishes, Inc.



6. Pratt & Lambert.
7. Sherwin-Williams Company (The).

## 2.2 PAINT, GENERAL

- A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- B. Unless otherwise indicated, provide factory-mixed coatings. When required, mix coatings to correct consistency in accordance with manufacturer's instructions before application. Do not reduce, thin, or dilute coatings or add materials to coatings unless such a procedure is specifically described in manufacturer's product instructions.
- C. Material Compatibility:
  1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
  2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- D. VOC Content: Provide materials that comply with VOC limits of authorities having jurisdiction.
- E. Colors: As indicated on Drawings.

## 2.3 ACCESSORIES

- A. Coating Application Accessories: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials required per manufacturer's specifications.

## 2.4 PRIMERS/SEALERS

- A. Primer, Alkali Resistant, Water Based: MPI #3.
  1. Sherwin-Williams Company (The); S-W Loxon Concrete & Masonry Primer/Sealer, A24W8300.
- B. Primer, Bonding, Water Based: MPI #17.
  1. Sherwin-Williams Company (The); Multi-Purpose Interior/Exterior Latex Primer/Sealer B51-450 Series.

## 2.5 METAL PRIMERS

- A. Primer, Galvanized, Water Based: MPI #134.
  1. Sherwin-Williams Company (The); S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series.

## 2.6 WOOD PRIMERS

- A. Primer, Latex for Exterior Wood: MPI #6.
  - 1. Sherwin-Williams Company (The); S-W Exterior Latex Wood Primer, B42W08041.

## 2.7 WATER-BASED PAINTS

- A. Latex, Exterior Flat (Gloss Level 1): MPI #10.
  - 1. Sherwin-Williams Company (The); S-W A-100 Exterior Latex Flat, A6-100 Series.
- B. Latex, Exterior Low Sheen (Gloss Level 3-4): MPI #15.
  - 1. Sherwin-Williams Company (The); S-W A-100 Exterior Latex Low Sheen, A12 Series.
- C. Latex, Exterior Semi-Gloss (Gloss Level 5): MPI #11.
  - 1. Sherwin-Williams Company (The); S-W A-100 Exterior Latex Gloss, A8 Series.
- D. Light Industrial Coating, Exterior, Water Based, Semi-Gloss (Gloss Level 5): MPI #163.
  - 1. Sherwin-Williams Company (The); S-W Pro Industrial Acrylic, Semi-Gloss, B66-650 Series.

## 2.8 SOURCE QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:
  - 1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
  - 2. Testing agency will perform tests for compliance with product requirements.
  - 3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
  - 1. Gypsum Board: 12 percent.

- C. Exterior Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- E. Do not begin application of coatings until substrates have been properly prepared. Notify Architect of unsatisfactory conditions before proceeding.
- F. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- G. Proceed with coating application only after unsatisfactory conditions have been corrected.
  - 1. Application of coating indicates acceptance of surfaces and conditions.

### 3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
  - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
  - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints. Clean per SSPC-SP1 using detergent and water or a degreasing cleaner to remove greases and oils. Apply a test area, priming as required. Allow the coating to dry at least one week before testing. If adhesion is poor, Brush Blast per SSPC-SP7 as necessary to remove these treatments.
- E. Fiberglass and Plastic Trim Fabrication Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.
- F. Fiber-Cement Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

### 3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Manual."
  - 1. Use applicators and techniques suited for paint and substrate indicated.

2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
  3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
  4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
  5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Apply coatings using methods recommended by manufacturer.
- C. Uniformly apply coatings without runs, drips, or sags, without brush marks, and with consistent sheen.
- D. Apply coatings at spreading rate required to achieve the manufacturer's recommended dry film thickness.
- E. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
1. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.
- F. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- G. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
1. Paint the following work where exposed to view:
    - a. Equipment, including panelboards and switch gear.
    - b. Uninsulated metal piping.
    - c. Uninsulated plastic piping.
    - d. Pipe hangers and supports.
    - e. Metal conduit.
    - f. Plastic conduit.
    - g. Tanks that do not have factory-applied final finishes.

### 3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
1. Contractor shall touch up and restore painted surfaces damaged by testing.
  2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

### 3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. Protect finished coatings from damage until completion of Project. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces following manufacturer's recommendation for touch up or repair of damaged coatings. Repair any defects that will hinder the performance of the coatings.

### 3.6 EXTERIOR PAINTING SCHEDULE

#### A. Galvanized-Metal Substrates:

##### 1. Latex System:

- a. Prime Coat: Primer, galvanized, water based, MPI #134.
- b. Intermediate Coat: Latex, matching topcoat.
- c. Topcoat: Latex, semi-gloss (Gloss Level 5), MPI #54.
- d. Topcoat: Latex, exterior gloss (Gloss Level 6), MPI #119.

##### 2. Water-Based Light Industrial Coating System:

- a. Prime Coat: Primer, galvanized, water based, MPI #134.
- b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
- c. Topcoat: Light industrial coating, exterior, water based, semi-gloss (Gloss Level 5), MPI #163.

#### B. Fiberglass and Plastic Trim Fabrication Substrates:

##### 1. Latex System:

- a. Prime Coat: Primer, bonding, water based, MPI #17.
- b. Intermediate Coat: Latex, exterior, matching topcoat.
- c. Topcoat: Latex, exterior semi-gloss (Gloss Level 5), MPI #11.

#### C. Exterior Gypsum Board Substrates:

##### 1. Latex System (Flat):

- a. Prime Coat: Latex for exterior wood, MPI #6.
- b. Intermediate Coat: Latex, exterior, matching topcoat.
- c. Topcoat: Latex, exterior flat (Gloss Level 1), MPI #10.

##### 2. Latex System (Low Sheen):

- a. Prime Coat: Latex for exterior wood, MPI #6.
  - b. Intermediate Coat: Latex, exterior, matching topcoat.
  - c. Topcoat: Latex, exterior, low sheen (Gloss Level 3-4), MPI #15.
3. Latex System (Semi-Gloss):
- a. Prime Coat: Latex for exterior wood, MPI #6.
  - b. Intermediate Coat: Latex, exterior, matching topcoat.
  - c. Topcoat: Latex, exterior semi-gloss (Gloss Level 5), MPI #11.
- D. Fiber-Cement Siding and Trim:
1. Latex System (Semi-Gloss):
- a. Prime Coat: Primer, alkali-resistant, water based, MPI #3.
  - b. Intermediate Coat: Latex, exterior, matching topcoat.
  - c. Topcoat: Latex, exterior semi-gloss (Gloss Level 5), MPI #11.

**END OF SECTION 09 91 13**

**SECTION 09 91 23**  
**INTERIOR PAINTING**

**PART 1 - GENERAL**

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

- A. Section includes surface preparation and the application of paint systems on interior substrates.
1. Concrete.
  2. Concrete masonry units (CMU).
  3. Steel.
  4. Wood.
  5. Gypsum board.
- B. Related Requirements:
1. Division 05 Sections for shop priming of metal substrates with primers specified in this Section.
  2. Section 09 91 13 "Exterior Painting" for surface preparation and the application of paint systems on exterior substrates.
  3. Section 09 93 00 "Staining and Transparent Finishing" for surface preparation and the application of wood stains and transparent finishes on interior wood substrates.

1.3 DEFINITIONS

- A. Gloss Level 1 (Flat): Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. Gloss Level 2 (Velvet): Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. Gloss Level 3 (Eggshell): 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- D. Gloss Level 4 (Satin): 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- E. Gloss Level 5 (Semi-Gloss): 35 to 70 units at 60 degrees, according to ASTM D 523.
- F. Gloss Level 6 (Gloss): 70 to 85 units at 60 degrees, according to ASTM D 523.
- G. Gloss Level 7 (High Gloss): More than 85 units at 60 degrees, according to ASTM D 523.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
  - 1. For paints and coatings used on the interior of the building, include a statement of VOC content in g/L.
- B. Samples: For each type of paint system and in each color and gloss of topcoat.
- C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
  - 1. Submit Samples on rigid backing, 8 inches square.
  - 2. Step coats on Samples to show each coat required for system.
  - 3. Label each coat of each Sample.
  - 4. Label each Sample for location and application area.
- D. Product List: For each product indicated, include the following:
  - 1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
  - 2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.
  - 3. VOC content in g/L.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
  - 1. Maintain containers in clean condition, free of foreign materials and residue.
  - 2. Remove rags and waste from storage areas daily.

#### 1.6 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints and coatings under environmental conditions outside manufacturer's absolute limits. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

### **PART 2 - PRODUCTS**

#### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles for the paint category indicated or comparable product by one of by one of the following, or equal approved by Professional:
  - 1. Benjamin Moore & Co.
  - 2. Coronado Paint.



3. Davis Paint Company.
4. Duron, Inc.
5. ICI Paints.
6. M.A.B. Paints.
7. McCormick Paints.
8. PPG Architectural Finishes, Inc.
9. Pratt & Lambert.
10. Sherwin-Williams Company (The).

## 2.2 PAINT, GENERAL

- A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- B. Unless otherwise indicated, provide factory-mixed coatings. When required, mix coatings to correct consistency in accordance with manufacturer's instructions before application. Do not reduce, thin, or dilute coatings or add materials to coatings unless such a procedure is specifically described in manufacturer's product instructions.
- C. Material Compatibility:
  1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
  2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- D. VOC Content: Paint and coating products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  1. Flat Paints and Coatings: 50 g/L.
  2. Nonflat Paints and Coatings: 150 g/L.
  3. Dry-Fog Coatings: 400 g/L.
  4. Primers, Sealers, and Undercoaters: 200 g/L.
  5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
  6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
  7. Pretreatment Wash Primers: 420 g/L.
  8. Floor Coatings: 100 g/L.
  9. Shellacs, Clear: 730 g/L.
  10. Shellacs, Pigmented: 550 g/L.
- E. Colors: As indicated on Drawings.
  1. As much as 20 percent of surface area may be painted with deep tones.

## 2.3 ACCESSORIES

- A. Coating Application Accessories: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials required per manufacturer's specifications.

## 2.4 BLOCK FILLERS

- A. Block Filler, Latex, Interior/Exterior: MPI #4.
  - 1. Sherwin-Williams Company (The); S-W PrepRite Interior/Exterior Block Filler B25W25.

## 2.5 PRIMERS/SEALERS

- A. Primer Sealer, Latex, Interior: MPI #50.
  - 1. Sherwin-Williams Company (The); S-W ProMar 200 Zero VOC Interior Latex Primer B28W02600.
- B. Primer Sealer, Interior, Institutional Low Odor/VOC: MPI #149.
  - 1. Sherwin-Williams Company (The); S-W ProMar 200 Zero VOC Interior Latex Primer B28W02600.
- C. Primer, Latex, for Interior Wood: MPI #39.
  - 1. Sherwin-Williams Company (The); S-W Multi-Purpose Latex Primer, B51-8000 Series.
- D. Primer, Bonding, Water Based: MPI #17.
  - 1. Sherwin-Williams Company (The); S-W Multi-Purpose Interior/Exterior Latex Primer/Sealer, B51-450 Series.

## 2.6 METAL PRIMERS

- A. Primer, Rust-Inhibitive, Water Based: MPI #107.
  - 1. Sherwin-Williams Company (The); S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series.
- B. Primer, Galvanized, Water Based: MPI #134.
  - 1. Sherwin-Williams Company (The); S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series.

## 2.7 WATER-BASED PAINTS

- A. Latex, Interior, Flat, (Gloss Level 1): MPI #53.
  - 1. Sherwin-Williams Company (The); S-W ProMar 200 Zero VOC Interior Latex Flat, B30-2600 Series.
- B. Latex, Interior, (Gloss Level 3): MPI #52.
  - 1. Sherwin-Williams Company (The); S-W ProMar 200 Zero VOC Interior Latex Eg-Shel, B24-2600 Series.
- C. Latex, Interior, (Gloss Level 4): MPI #43.

1. Sherwin-Williams Company (The); S-W ProMar 200 Zero VOC Interior Latex Semi-Gloss, B31-2600 Series.

D. Latex, Interior, Semi-Gloss, (Gloss Level 5): MPI #54.

1. Sherwin-Williams Company (The); S-W ProMar 200 Interior Latex Gloss, B21-200 Series.

## 2.8 FLOOR COATINGS

A. Floor Paint, Latex, Semi-Gloss:

1. Sherwin-Williams Company (The); S-W Armorseal Tread-Plex 100% Acrylic Water Based Floor Coating, B90 Series.

## 2.9 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Masonry (CMU): 12 percent.
3. Wood: 15 percent.
4. Gypsum Board: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

E. Do not begin application of coatings until substrates have been properly prepared. Notify Architect of unsatisfactory conditions before proceeding.

- F. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- G. Proceed with coating application only after unsatisfactory conditions have been corrected.
  - 1. Application of coating indicates acceptance of surfaces and conditions.

### 3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
  - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
  - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceed that permitted in manufacturer's written instructions.
- F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer.
  - 1. SSPC-SP 3, "Power Tool Cleaning."
- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- I. Wood Substrates:
  - 1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
  - 2. Sand surfaces that will be exposed to view, and dust off.
  - 3. Prime edges, ends, faces, undersides, and backsides of wood.
  - 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

### 3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
  - 1. Use applicators and techniques suited for paint and substrate indicated.
  - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
  - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
  - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
  - 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Apply coatings using methods recommended by manufacturer.
- C. Uniformly apply coatings without runs, drips, or sags, without brush marks, and with consistent sheen.
- D. Apply coatings at spreading rate required to achieve the manufacturer's recommended dry film thickness.
- E. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
  - 1. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.
- F. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- G. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
  - 1. Paint the following work where exposed in equipment rooms:
    - a. Equipment, including panelboards and switch gear.
    - b. Uninsulated metal piping.
    - c. Uninsulated plastic piping.
    - d. Pipe hangers and supports.
    - e. Metal conduit.
    - f. Plastic conduit.
    - g. Tanks that do not have factory-applied final finishes.
    - h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
  - 2. Paint the following work where exposed in occupied spaces:
    - a. Equipment, including panelboards.
    - b. Uninsulated metal piping.
    - c. Uninsulated plastic piping.
    - d. Pipe hangers and supports.

- e. Metal conduit.
  - f. Plastic conduit.
  - g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
  - h. Other items as directed by Architect.
3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

### 3.4 IDENTIFICATION OF INTERIOR FIRE- AND SMOKE-RATED WALLS AND PARTITIONS

- A. Markings and Identification: For fire walls, fire barriers, fire partitions, smoke barriers, and smoke partitions or any other wall required to have protected openings or penetrations in all occupancies other than R-2 and that have removable decorative ceiling allowing access to the concealed space; walls shall be effectively and permanently identified with signs or stenciling. Provide stenciled text on each side of walls and partitions in accessible spaces above suspended ceiling systems in order to indicate that the wall or partition construction is rated.
- 1. Text: "FIRE AND/OR SMOKE BARRIER – PROTECT ALL OPENINGS" or other text as required by authorities having jurisdiction.
    - a. Letter Height: Not less than 3 inches, with a minimum 3/8-inch stroke in a contrasting color.
    - b. Location: Centered 12 inches above suspended ceiling system.
    - c. Spacing: Located not less than 10 feet from the end of each wall and repeated at intervals not exceeding 10 feet measured horizontally along entire length of wall or partition.

### 3.5 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
- 1. Contractor shall touch up and restore painted surfaces damaged by testing.
  - 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

### 3.6 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

- D. Protect finished coatings from damage until completion of Project. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces following manufacturer's recommendation for touch up or repair of damaged coatings. Repair any defects that will hinder the performance of the coatings.

### 3.7 INTERIOR PAINTING SCHEDULE

#### A. Concrete Substrates, Nontraffic Surfaces:

- 1. Latex System (Flat):
  - a. Prime Coat: Primer sealer, latex, interior, MPI #50.
  - b. Intermediate Coat: Latex, interior, matching topcoat.
  - c. Topcoat: Latex, interior, flat, (Gloss Level 1), MPI #53.
- 2. Latex System (Eggshell):
  - a. Prime Coat: Primer sealer, latex, interior, MPI #50.
  - b. Intermediate Coat: Latex, interior, matching topcoat.
  - c. Topcoat: Latex, interior, (Gloss Level 3), MPI #52
- 3. Latex System (Satin):
  - a. Prime Coat: Primer sealer, latex, interior, MPI #50.
  - b. Intermediate Coat: Latex, interior, matching topcoat.
  - c. Topcoat: Latex, interior, (Gloss Level 4), MPI #43.
- 4. Latex System (Semi-Gloss):
  - a. Prime Coat: Primer sealer, latex, interior, MPI #50.
  - b. Intermediate Coat: Latex, interior, matching topcoat.
  - c. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5), MPI #54.

#### B. Concrete Substrates, Traffic Surfaces:

- 1. Latex Floor Enamel System:
  - a. Prime Coat: Floor paint, latex, semi-gloss.
  - b. Intermediate Coat: Floor paint, latex, semi-gloss.
  - c. Topcoat: Floor paint, latex, semi-gloss.

#### C. CMU Substrates:

- 1. Latex System (Flat):
  - a. Block Filler: Block filler, latex, interior/exterior, MPI #4.
  - b. Intermediate Coat: Latex, interior, matching topcoat.
  - c. Topcoat: Latex, interior, flat, (Gloss Level 1), MPI #53.
- 2. Latex System (Eggshell):
  - a. Block Filler: Block filler, latex, interior/exterior, MPI #4.
  - b. Intermediate Coat: Latex, interior, matching topcoat.
  - c. Topcoat: Latex, interior, (Gloss Level 3), MPI #52.

3. Latex System (Satin):
    - a. Block Filler: Block filler, latex, interior/exterior, MPI #4.
    - b. Intermediate Coat: Latex, interior, matching topcoat.
    - c. Topcoat: Latex, interior, (Gloss Level 4), MPI #43.
  4. Latex System (Semi-Gloss):
    - a. Block Filler: Block filler, latex, interior/exterior, MPI #4.
    - b. Intermediate Coat: Latex, interior, matching topcoat.
    - c. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5), MPI #54.
- D. Steel Substrates:
1. Latex over Alkyd Primer System:
    - a. Prime Coat: Shop primer specified in Section where substrate is specified.
    - b. Intermediate Coat: Latex, interior, matching topcoat.
    - c. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5), MPI #54.
- E. Galvanized-Metal Substrates:
1. Latex over Waterborne Primer System:
    - a. Prime Coat: Primer, galvanized, water based, MPI #134.
    - b. Intermediate Coat: Latex, interior, matching topcoat.
    - c. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5), MPI #54.
- F. Wood Substrates: Including wood trim, architectural woodwork, and doors.
1. Latex System:
    - a. Prime Coat: Primer, latex, for interior wood, MPI #39.
    - b. Intermediate Coat: Latex, interior, matching topcoat.
    - c. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5), MPI #54.
- G. Fiberglass and Plastic Substrates:
1. Latex System:
    - a. Prime Coat: Primer, bonding, water based, MPI #17.
    - b. Intermediate Coat: Latex, interior, matching topcoat.
    - c. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5), MPI #54.
- H. Gypsum Board Substrates:
1. Latex System (Flat):
    - a. Prime Coat: Primer sealer, latex, interior, MPI #50.
    - b. Intermediate Coat: Latex, interior, matching topcoat.
    - c. Topcoat: Latex, interior, flat, (Gloss Level 1), MPI #53.
  2. Latex System (Eggshell):
    - a. Prime Coat: Primer sealer, latex, interior, MPI #50.



- b. Intermediate Coat: Latex, interior, matching topcoat.
  - c. Topcoat: Latex, interior, (Gloss Level 3), MPI #52.
- 3. Latex System (Satin):
  - a. Prime Coat: Primer sealer, latex, interior, MPI #50.
  - b. Intermediate Coat: Latex, interior, matching topcoat.
  - c. Topcoat: Latex, interior, (Gloss Level 4), MPI #43.
- 4. Latex System (Semi-Gloss):
  - a. Prime Coat: Primer sealer, latex, interior, MPI #50.
  - b. Intermediate Coat: Latex, interior, matching topcoat.
  - c. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5), MPI #54.

**END OF SECTION 09 91 23**

## SECTION 10 14 19

### DIMENSIONAL LETTER SIGNAGE

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section includes individually mounted cast dimensional characters.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For dimensional letter signs.
  - 1. Include fabrication and installation details and attachments to other work.
  - 2. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
  - 3. Show message list, typestyles, graphic elements, and layout for each sign at least half size.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
  - 1. Dimensional Characters: Half-size Sample of each type of dimensional character.
  - 2. Exposed Accessories: Half-size Sample of each accessory type.

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.

##### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For signs to include in maintenance manuals.

## 1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Deterioration of finishes beyond normal weathering.
    - b. Separation or delamination of sheet materials and components.
  - 2. Warranty Period: Five (5) years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 DIMENSIONAL CHARACTERS

- A. Cast Characters: Characters with uniform faces, sharp corners, and precisely formed lines and profiles, and as follows:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by the Professional:
    - a. ACE Sign Systems, Inc.
    - b. A. R. K. Ramos Signage Systems.
    - c. ASI Sign Systems, Inc.
    - d. Gemini Incorporated.
    - e. Metal Arts; Division of L & H Mfg. Co.
    - f. Southwell Company (The).
  - 2. Character Material: Cast aluminum.
  - 3. Character Height: As indicated on Drawings.
  - 4. Thickness: Manufacturer's standard for size of character.
  - 5. Finishes:
    - a. Integral Aluminum Finish: Anodized color as selected by Architect from standard range of industry colors and color densities.
    - b. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard, in color as selected by Architect from manufacturer's standard range.
  - 6. Mounting: Concealed studs.
  - 7. Typeface: As indicated on Drawings by manufacturer's designation or, if not indicated, as selected by Architect from manufacturer's full range.

### 2.2 DIMENSIONAL CHARACTER MATERIALS

- A. Aluminum Castings: ASTM B 26/B 26M, alloy and temper recommended by sign manufacturer for casting process used and for type of use and finish indicated.
- B. Aluminum Sheet and Plate: ASTM B 209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- C. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

## 2.3 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signage, noncorrosive and compatible with each material joined, and complying with the following:
  - 1. Use concealed fasteners and anchors unless indicated to be exposed.
  - 2. For exterior exposure, furnish stainless-steel devices unless otherwise indicated.
  - 3. Sign Mounting Fasteners:
    - a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
    - b. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
- B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

## 2.4 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
  - 1. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
  - 2. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
  - 3. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
  - 4. Internally brace signs for stability and for securing fasteners.
  - 5. Provide rebates, lugs, and brackets necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
  - 6. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.

## 2.5 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.
- D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

## 2.6 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, **Class I, 0.018 mm** or thicker.
- B. Color Anodic Finish: AAMA 611, **Class I, 0.018 mm** or thicker.
- C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of signage work.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
  - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
  - 2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
  - 3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- B. Mounting Methods:
  - 1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
    - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
    - b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.
  - 2. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.

- a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place spacers on studs, place sign in position, and push until spacers are pinched between sign and substrate, embedding the stud ends in holes. Temporarily support sign in position until adhesive fully sets.
- b. Thin or Hollow Surfaces: Place spacers on studs, place sign in position with spacers pinched between sign and substrate, and install washers and nuts on stud ends projecting through opposite side of surface, and tighten.

### 3.3 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed characters and signs that do not comply with specified requirements. Replace characters with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

**END OF SECTION 10 14 19**

## SECTION 10 21 13.19

### PLASTIC TOILET COMPARTMENTS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section includes solid-plastic toilet compartments configured as toilet enclosures and urinal screens.
- B. Related Requirements:
  - 1. Section 06 10 53 "Miscellaneous Rough Carpentry" for blocking.
  - 2. Section 10 28 00 "Toilet, Bath, and Laundry Accessories" for toilet tissue dispensers, grab bars, purse shelves, and similar accessories mounted on toilet compartments.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for toilet compartments.
- B. Shop Drawings: For toilet compartments. Include plans, elevations, sections, details, and attachment details.
  - 1. Show locations of cutouts for compartment-mounted toilet accessories.
  - 2. Show locations of centerlines of toilet fixtures.
- C. Samples for each type of toilet compartment material indicated.
- D. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:
  - 1. Each type of material, color, and finish required for toilet compartments, prepared on 6-inch-square Samples of same thickness and material indicated for Work.
  - 2. Each type of hardware and accessory.

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of toilet compartment.

## 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For toilet compartments to include in maintenance manuals.

## 1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Flame-Spread Index: 25 or less.
  - 2. Smoke-Developed Index: 450 or less.
- B. Regulatory Requirements: Comply with applicable provisions in the 2010 ADA Standards and ICC A117.1 for toilet compartments designated as accessible.

### 2.2 SOLID-PLASTIC TOILET COMPARTMENTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by the Professional:
  - 1. Accurate Partitions Corporation.
  - 2. American Sanitary Partition Corporation.
  - 3. Bradley Corporation; Mills Partitions.
  - 4. General Partitions Mfg. Corp.
  - 5. Global Steel Products Corp.
  - 6. Metpar Corp.
  - 7. Scranton Products.
- B. Toilet-Enclosure Style: Overhead braced and Floor anchored.
- C. Entrance-Screen Style: Overhead braced and Floor anchored.
- D. Urinal-Screen Style: Wall hung.
- E. Door, Panel, and Pilaster Construction: Solid, high-density polyethylene (HDPE) panel material, not less than 1 inch thick, seamless, with eased edges, no-sightline system, and with homogenous color and pattern throughout thickness of material.
  - 1. Heat-Sink Strip: Manufacturer's standard continuous, extruded-aluminum or [stainless-steel strip fastened to exposed bottom edges of solid-plastic components to hinder malicious combustion.
  - 2. Color and Pattern: One color and pattern in each room as indicated on Drawings by manufacturer's designations or, if not indicated, as selected by Architect from manufacturer's full range.
- F. Pilaster Shoes and Sleeves (Caps): Manufacturer's standard design; stainless steel.



- G. Brackets (Fittings):
  - 1. Full-Height (Continuous) Type: Manufacturer's standard design; extruded aluminum.

## 2.3 HARDWARE AND ACCESSORIES

- A. Hardware and Accessories: Manufacturer's standard operating hardware and accessories.
  - 1. Material: Clear-anodized aluminum.
  - 2. Hinges: Manufacturer's standard continuous, cam type that swings to a closed or partially open position, allowing emergency access by lifting door.
  - 3. Latch and Keeper: Manufacturer's standard surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
  - 4. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories.
  - 5. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors.
  - 6. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.
- B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
- C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless-steel, hot-dip galvanized-steel, or other rust-resistant, protective-coated steel compatible with related materials.

## 2.4 MATERIALS

- A. Aluminum Castings: ASTM B 26/B 26M.
- B. Aluminum Extrusions: ASTM B 221.
- C. Stainless-Steel Sheet: ASTM A 666, Type 304, stretcher-leveled standard of flatness.
- D. Stainless-Steel Castings: ASTM A 743/A 743M.

## 2.5 FABRICATION

- A. Fabrication, General: Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories where required for attachment of toilet accessories.
- B. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.

- C. Floor-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.
- D. Door Size and Swings: Unless otherwise indicated, provide 24-inch- wide, in-swinging doors for standard toilet compartments and 36-inch- wide, out-swinging doors with a minimum 32-inch-wide, clear opening for compartments designated as accessible.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.
  - 1. Confirm location and adequacy of blocking and supports required for installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 INSTALLATION**

- A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
  - 1. Maximum Clearances:
    - a. Pilasters and Panels: 1/2 inch.
    - b. Panels and Walls: 1 inch.
  - 2. Full-Height (Continuous) Brackets: Secure panels to walls and to pilasters with full-height brackets.
    - a. Locate bracket fasteners so holes for wall anchors occur in masonry or tile joints.
    - b. Align brackets at pilasters with brackets at walls.
- B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.
- C. Floor-Anchored Units: Set pilasters with anchors penetrating not less than 2 inches into structural floor unless otherwise indicated in manufacturer's written instructions. Level, plumb, and tighten pilasters. Hang doors and adjust so tops of doors are level with tops of pilasters when doors are in closed position.
- D. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

### 3.3 ADJUSTING

- A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

**END OF SECTION 10 21 13.19**

## SECTION 10 21 23

### CUBICLE CURTAINS AND TRACK

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:

- 1. Cubicle-curtain tracks and carriers.
- 2. Cubicle curtains.

- B. Related Requirements:

- 1. Section 06 10 53 "Miscellaneous Rough Carpentry" for supplementary wood framing and blocking for mounting items requiring anchorage.
- 2. Section 09 22 16 "Non-Structural Metal Framing" for supplementary metal framing and blocking for mounting items requiring anchorage.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- 1. For each type of curtain fabric indicated, include durability, laundry temperature limits, fade resistance, applied curtain treatments, and fire-test-response characteristics.

- B. Shop Drawings: For curtains and tracks.

- 1. Show layout and types of cubicles, sizes of curtains, number of carriers, anchorage details, and conditions requiring accessories. Indicate dimensions taken from field measurements.
- 2. Include details of blocking for track support.

- C. Samples for Verification: For each type of product required, prepared on Samples of size indicated below:

- 1. Curtain Fabric: Not less than 10 inches square and showing complete pattern repeat, from dye lot used for the Work, with specified treatments applied. Mark top and face of material.
- 2. Mesh Top: Not less than 10 inches square.

- D. Product Schedule: For curtains and tracks. Use same designations indicated on Drawings.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For curtains, tracks, and hardware to include in operation and maintenance manuals.

### **PART 2 - PRODUCTS**

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Cubicle Curtains: Provide curtain fabrics with the following characteristics:
  - 1. Laundering: Launderable to a water temperature of not less than 160 deg F.
  - 2. Flame Resistance: Provide fabrics identical to those that have passed NFPA 701 when tested by a qualified testing agency acceptable to authorities having jurisdiction.
    - a. Identify fabrics with appropriate markings of a qualified testing agency.

#### 2.2 CUBICLE-CURTAIN SUPPORT SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by Professional:
  - 1. Automatic Devices Company.
  - 2. Barjan Manufacturing, LTD.
  - 3. Construction Specialties, Inc.
  - 4. Imperial Fastener Company.
  - 5. InPro Corporation.
  - 6. AR Nelson.
- B. Extruded-Aluminum Curtain Track: Not less than 1-1/4 inches wide by 3/4 inch high.
  - 1. Track Minimum Wall Thickness: Manufacturer's standard.
  - 2. Curved Track: Factory-fabricated, 12-inch- radius bends.
  - 3. Finish: Clear anodized.
- C. Curtain Track Accessories: Fabricate splices, end caps, connectors, end stops, coupling and joining sleeves, wall flanges, brackets, ceiling clips, and other accessories from same material and with same finish as track.
  - 1. End Stop: Removable with carrier hook.
- D. Curtain Roller Carriers: Two nylon rollers and nylon axle with chrome-plated steel hook.
- E. Exposed Fasteners: Stainless steel.
- F. Concealed Fasteners: Stainless steel.

#### 2.3 CURTAINS

- A. Fabric: Curtain manufacturer's standard, 100 percent polyester; inherently and permanently flame resistant, stain resistant, and antimicrobial.

1. Products: Subject to compliance with requirements, provide products indicated in Finish Schedule on Drawings, or equal approved by Professional.
- B. Mesh Top: Not less than 20-inch-high mesh top.
  1. Mesh: No. 42 nylon mesh.
- C. Beaded-Chain Curtain Drop: 6 inches long; nickel-plated steel with aluminum hook.

## 2.4 CURTAIN FABRICATION

- A. Continuous Curtain Panels:
  1. Width: Equal to track length from which curtain is hung plus 10 percent of added fullness, but not less than 12 inches of added fullness.
  2. Length: Equal to floor-to-ceiling height, minus depth of track and carrier at top, and minus clearance above the finished floor as follows:
    - a. Cubicle Curtains: 12 inches.
  3. Mesh Top: Top hem of mesh not less than 1 inch and not more than 1-1/2 inches wide, triple thickness, reinforced with integral web, and double lockstitched. Double lockstitch bottom of mesh directly to 1/2-inch triple thickness, top hem of curtain fabric.
  4. Bottom Hem: Not less than 1 inch and not more than 1-1/2 inches wide, double thickness and double lockstitched.
  5. Side Hems: Not less than 1/2 inch and not more than 1-1/4 inches wide, with double turned edges, and single lockstitched.
  6. Vertical Seams: Not less than 1/2 inch wide, double turned and double stitched.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install tracks level and plumb, according to manufacturer's written instructions.
- B. For tracks of up to 20 feet in length, provide track fabricated from single, continuous length.
  1. Curtain-Track Mounting: As indicated on Drawings.
- C. Surface-Track Mounting: Fasten tracks to ceilings at intervals recommended by manufacturer. Fasten tracks to structure at each splice and tangent point of each corner. Center fasteners in track to ensure unencumbered carrier operation. Attach track to ceiling as follows:
  1. Mechanically fasten to furring through suspended ceiling with screw and tube spacer.

- D. Suspended-Track Mounting: Install track with manufacturer's standard tubular aluminum suspended supports at intervals and with fasteners recommended by manufacturer. Fasten supports to structure. Provide supports at each splice and tangent point of each corner. Secure ends of track to wall with flanged fittings or brackets.
- E. Track Accessories: Install splices, end caps, connectors, end stops, coupling and joining sleeves, and other accessories as required for a secure and operational installation.
- F. Curtain Carriers: Provide curtain carriers adequate for 6-inch spacing along full length of curtain plus an additional carrier.
- G. Cubicle Curtains: Hang curtains on each curtain track.

**END OF SECTION 10 21 23**

## SECTION 10 26 00

### WALL AND DOOR PROTECTION

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:

- 1. Wall guards.
- 2. Impact-resistant handrails.
- 3. Corner guards.
- 4. Abuse-resistant wall coverings.

- B. Related Requirements:

- 1. Section 06 40 00 "Interior Architectural Woodwork" for solid-surface wall cladding used as wall protection.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- 1. Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes.
  - a. For installation adhesives, include printed statement of VOC content in g/L.

- B. Shop Drawings: For each type of wall and door protection showing locations and extent.

- 1. Include plans, elevations, sections, and attachment details.

- C. Samples for Verification: For each type of impact-resistant wall protection indicated.

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of handrail.

- B. Material Certificates: For each type of exposed plastic material.

- C. Sample Warranty: For special warranty.



## 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of wall and door protection product to include in maintenance manuals.
  - 1. Include recommended methods and frequency of maintenance for maintaining best condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to finishes and performance.

## 1.6 QUALITY ASSURANCE

- A. Vendor Qualifications: A vendor that is certified for chain of custody by and FSC-accredited certification body.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store wall and door protection in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
  - 1. Maintain room temperature within storage area at not less than 70 deg F during the period plastic materials are stored.
  - 2. Keep plastic materials out of direct sunlight.
  - 3. Store plastic wall- and door-protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70 deg F.
    - a. Store corner-guard covers in a vertical position.
    - b. Store wall-guard and handrail covers in a horizontal position.

## 1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of wall- and door-protection units that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including detachment of components from each other or from the substrates, delamination, and permanent deformation beyond normal use.
    - b. Deterioration of metals, metal finishes, plastics, and other materials beyond normal use.
  - 2. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain wall- and door-protection products of each type from single source from single manufacturer.

## 2.2 PERFORMANCE REQUIREMENTS

- A. Surface Burning Characteristics: Comply with ASTM E 84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame-Spread Index: 25 or less.
  2. Smoke-Developed Index: 450 or less.

## 2.3 WALL GUARDS

- A. Crash Rail (CR): Heavy-duty, PVC-free assembly consisting of continuous snap-on plastic cover installed over concealed retainer; designed to withstand impacts.
1. Basis-of-Design Product: Subject to compliance with requirements, provide as indicated in Finish Schedule on Drawings or comparable product by one of the following, or equal approved by the Professional:
    - a. American Floor Products Co., Inc.
    - b. Arden Architectural Specialties, Inc.
    - c. Construction Specialties, Inc.
    - d. IPC Door and Wall Protection Systems; Division of InPro Corporation.
    - e. Korogard Wall Protection Systems; a division of RJF International Corporation.
    - f. Pawling Corporation.
    - g. Tepromark International, Inc.
    - h. WallGuard.com.
  2. Cover: Extruded rigid plastic, minimum 0.100-inch wall thickness; as follows:
    - a. Profile: Flat.
      - 1) Dimensions: As indicated on the Finish Legend on the Drawings.
      - 2) Surface: Uniform.
    - b. Color and Texture: As indicated in Finish Schedule on Drawings.
  3. Continuous Retainer: Minimum 0.080-inch-thick, one-piece, extruded aluminum.
  4. Retainer Clips: Manufacturer's standard impact-absorbing clips designed for heavy-duty performance.
  5. Bumper: Continuous, resilient bumper cushion(s).
  6. End Caps and Corners: Prefabricated, injection-molded plastic; matching color cover; field adjustable for close alignment with snap-on cover.
  7. Accessories: Concealed splices and mounting hardware.
  8. Mounting: Surface mounted directly to wall.

## 2.4 IMPACT-RESISTANT HANDRAILS (HR-)

- A. Structural Performance: Handrails, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
1. Uniform load of 50 lbf/ft. applied in any direction.
  2. Concentrated load of 200 lb/ft. applied in any direction.
  3. Uniform and concentrated loads need not be assumed to act concurrently.

B. Combination Plastic-Metal Handrail: Manufacturer's standard, PVC-free assembly consisting of single round plastic handrail with stainless-steel end-caps returning to wall.

1. Basis-of-Design Product: Subject to compliance with requirements, provide as indicated in Finish Schedule on Drawings or comparable product by one of the following, or equal approved by the Professional:
  - a. American Floor Products Co., Inc.
  - b. Arden Architectural Specialties, Inc.
  - c. Construction Specialties, Inc.
  - d. IPC Door and Wall Protection Systems; Division of InPro Corporation.
  - e. Korogard Wall Protection Systems; a division of RJF International Corporation.
  - f. Pawling Corporation.
  - g. Tepromark International, Inc.
  - h. WallGuard.com.
2. Handrail: Oval handrail, crash-rail, and stainlesssteel end caps with 1-1/2-inch-diameter gripping surface with minimum 0.078-inch-thick, extruded rigid plastic.
  - a. Color and Texture: As indicated in Finish Schedule on Drawings.
3. End Caps, Returns, Corners, and Mounting Brackets: Stainless steel.

## 2.5 CORNER GUARDS (CG-)

A. Flush-Mounted, Plastic-Cover Corner Guards: Manufacturer's standard, PVC-free assembly consisting of snap-on, resilient plastic cover installed over continuous retainer; attaches directly to drywall and feathered in flush to adjacent wall surface.

1. Basis-of-Design Product: Subject to compliance with requirements, provide as indicated in Finish Schedule on Drawings or comparable product by one of the following, or equal approved by the Professional:
  - a. American Floor Products Co., Inc.
  - b. Arden Architectural Specialties, Inc.
  - c. Balco, Inc.
  - d. Construction Specialties, Inc.
  - e. IPC Door and Wall Protection Systems; Division of InPro Corporation.
  - f. Korogard Wall Protection Systems; a division of RJF International Corporation.
  - g. Musson Rubber Company.
  - h. Pawling Corporation.
  - i. Tepromark International, Inc.
  - j. WallGuard.com.
2. Cover: Extruded rigid plastic, minimum 0.078-inch wall thickness; as follows:
  - a. Profile: Nominal 3-inch-long leg and 1/4-inch corner radius.
  - b. Height: As indicated.
  - c. Color and Texture: As indicated in Finish Schedule on Drawings.
3. Continuous Retainer: Minimum 0.060-inch-thick, one-piece, extruded aluminum.
4. Fire Ratings: Coordinate with rated partition types as indicated on drawings.

## 2.6 ABUSE-RESISTANT WALL COVERINGS (WP-)

- A. Abuse-Resistant Sheet Wall Covering: Fabricated from semi-rigid, PVC-free, plastic sheet wall-covering material.
1. Basis-of-Design Product: Subject to compliance with requirements, provide as indicated in Finish Schedule on Drawings or comparable product by one of the following, or equal approved by the Professional:
    - a. American Floor Products Co., Inc.
    - b. Arden Architectural Specialties, Inc.
    - c. Balco, Inc.
    - d. Construction Specialties, Inc.
    - e. IPC Door and Wall Protection Systems; Division of InPro Corporation.
    - f. Korogard Wall Protection Systems; a division of RJF International Corporation.
    - g. Kwalu, LLC.
    - h. Pawling Corporation.
    - i. Tepromark International, Inc.
    - j. WallGuard.com.
  2. Size: 48 by 96 inches for sheet.
  3. Sheet Thickness: As indicated in Finish Schedule on Drawings.
  4. Color and Texture: As indicated in Finish Schedule on Drawings.
  5. Height: As indicated.
  6. Joint Sealant: Manufacturer's standard color-matched sealant at vertical joints and top of wainscot
  7. Mounting: Manufacturer's recommended adhesive.

## 2.7 DECORATIVE ABUSE-RESISTANT WALL COVERINGS (WP-, WP-)

- A. Abuse-Resistant Sheet Wall Covering: Fabricated from semi-rigid, PVC-free, plastic sheet wall-covering material.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Construction Specialties, Acrovyn by Design Custom Graphic Wall Covering or comparable product by one of the following, or equal approved by the Professional:
    - a. American Floor Products Co., Inc.
    - b. Arden Architectural Specialties, Inc.
    - c. Balco, Inc.
    - d. Construction Specialties, Inc.
    - e. IPC Door and Wall Protection Systems; Division of InPro Corporation.
    - f. Korogard Wall Protection Systems; a division of RJF International Corporation.
    - g. Kwalu, LLC.
    - h. Pawling Corporation.
    - i. Tepromark International, Inc.
    - j. WallGuard.com.
  2. Size: 48 by 96 inches for sheet.
  3. Sheet Thickness: As indicated in Finish Schedule on Drawings.
  4. Color and Texture: As indicated in Finish Schedule on Drawings.
  5. Height: As indicated.
  6. Joint Sealant: Manufacturer's standard color-matched sealant at vertical joints and edge perimeters.
  7. Mounting: Manufacturer's recommended adhesive.

8. Trim: None

## 2.8 MATERIALS

- A. Plastic Materials: Chemical- and stain-resistant, high-impact-resistant plastic with integral color throughout; extruded and sheet material as required; thickness as indicated.
- B. Adhesive: As recommended by protection product manufacturer.
  - 1. Adhesives shall have a VOC content of 70 g/L or less.

## 2.9 FABRICATION

- A. Fabricate wall and door protection according to requirements indicated for design, performance, dimensions, and member sizes, including thicknesses of components.
- B. Factory Assembly: Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.
- C. Quality: Fabricate components with uniformly tight seams and joints and with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

## 2.10 FINISHES

- A. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine walls to which wall protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
  - 1. For wall protection attached with adhesive, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Complete finishing operations, including painting, before installing wall protection.
- B. Before installation, clean substrate to remove dust, debris, and loose particles.

### 3.3 INSTALLATION

- A. Installation Quality: Install wall protection according to manufacturer's written instructions, level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
- B. Mounting Heights: Install wall protection in locations and at mounting heights indicated on Drawings.
- C. Accessories: Provide splices, mounting hardware, anchors, and other accessories required for a complete installation.
  - 1. Provide anchoring devices and suitable locations to withstand imposed loads.
  - 2. Where splices occur in horizontal runs of more than 20 feet, splice aluminum retainers and plastic covers at different locations along the run, but no closer than 12 inches apart.
  - 3. Adjust end and top caps as required to ensure tight seams.
- D. Abuse-Resistant Wall Covering: Leave 1/16-inch gap between sections of wall covering, as recommended by manufacturer. Seal gaps and seal top of wainscots with manufacturer's standard color-match sealant.

### 3.4 CLEANING

- A. Immediately after completion of installation, clean plastic covers and accessories using a standard ammonia-based household cleaning agent.
- B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION 10 26 00

## SECTION 10 28 00

### TOILET, BATH, AND LAUNDRY ACCESSORIES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:

- 1. Public-use washroom accessories.
- 2. Private-use bathroom accessories.
- 3. Childcare accessories.
- 4. Underlavatory guards.
- 5. Custodial accessories.

- B. Owner-Furnished Material: Toilet paper dispenser, paper towel dispenser, soap dispenser, and hand sanitizer dispenser.

- C. Related Requirements:

- 1. Section 08 83 00 "Mirrors" for frameless mirrors.
- 2. Section 09 30 13 "Ceramic Tiling" for ceramic toilet and bath accessories.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Submit manufacturer's catalog cut sheets, data sheets, and installation instructions.

- B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

- 1. Identify locations using room designations indicated.
- 2. Identify products using designations indicated.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Submit operating and maintenance instructions for equipment requiring periodic maintenance.

#### 1.5 QUALITY ASSURANCE

- A. Source Limitations: For products listed together in the same Part 2 articles, obtain products from single source from single manufacturer.

#### 1.6 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.
- C. Do not install accessories until room finishes are completed.

### **PART 2 - PRODUCTS**

#### 2.1 PUBLIC-USE WASHROOM ACCESSORIES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following, or equal approved by the Professional:
  - 1. A & J Washroom Accessories, Inc.
  - 2. American Specialties, Inc.
  - 3. Bobrick Washroom Equipment, Inc.
  - 4. Bradley Corporation.
  - 5. GAMCO Specialty Accessories; a division of Bobrick Washroom Equipment, Inc.
  - 6. Tubular Specialties Manufacturing, Inc.
- B. Grab Bar:
  - 1. Basis-of-Design Product: Bobrick Washroom Equipment.; B-5806 Series.
  - 2. Mounting: Flanges with concealed fasteners.
  - 3. Material: Stainless steel, 0.05 inch thick.
    - a. Finish: Smooth, No. 4 finish (satin) on ends and slip-resistant texture in grip area.
  - 4. Outside Diameter: 1-1/4 inches.



5. Configuration and Length:
  - a. Side Wall Grab Bar: 42 inches in length.
  - b. Toilet Wall Grab Bar: 36 inches in length.
  - c. Vertical Wall Grab Bar: 18 inches in length.

C. Sanitary-Napkin Disposal Unit:

1. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-254
2. Mounting: Surface mounted.
3. Door or Cover: Self-closing, disposal-opening cover and hinged face panel with tumbler lockset.
4. Receptacle: Removable.
5. Material and Finish: Stainless steel, No. 4 finish (satin).

D. Sanitary-Napkin Disposal Unit:

1. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; B-354
2. Mounting: Partition mounted.
3. Door or Cover: Self-closing, disposal-opening cover and hinged face panel with tumbler lockset.
4. Receptacle: Removable.
5. Material and Finish: Stainless steel, No. 4 finish (satin).

E. Mirror Unit:

1. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; Model B-290.
2. Frame: Stainless-steel angle, 0.05 inch thick.
  - a. Corners: Manufacturer's standard.
3. Hangers: Produce rigid, tamper- and theft-resistant installation, using method indicated below.
  - a. One-piece, galvanized-steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
4. Size: As indicated on Drawings.

## 2.2 PRIVATE-USE BATHROOM ACCESSORIES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following, or equal approved by the Professional:

1. Basco, Inc.
2. Bobrick Washroom Equipment, Inc.
3. Franklin Brass by Liberty Hardware Manufacturing Corporation; a Masco company.
4. GAMCO Specialty Accessories; a division of Bobrick Washroom Equipment, Inc.
5. Ginger; a Masco company.
6. Seachrome Corporation.
7. Tubular Specialties Manufacturing, Inc.

B. Grab Bar:

1. Basis-of-Design Product: Bobrick Washroom Equipment.; B-5806 Series.
2. Mounting: Flanges with concealed fasteners.
3. Material: Stainless steel, 0.05 inch thick.
  - a. Finish: Smooth, No. 4 finish (satin) on ends and slip-resistant texture in grip area.
4. Outside Diameter: 1-1/4 inches.
5. Configuration and Length:
  - a. Side Wall Grab Bar: 42 inches in length.
  - b. Toilet Wall Grab Bar: 36 inches in length.
  - c. Vertical Wall Grab Bar: 18 inches in length.

C. Grab Bar:

1. Basis-of-Design Product: Bobrick Washroom Equipment.; B-5837.
2. Mounting: Flanges with concealed fasteners.
3. Material: Stainless steel, 0.05 inch thick.
  - a. Finish: Smooth, No. 4 finish (satin) on ends and slip-resistant texture in grip area.
4. Outside Diameter: 1-1/4 inches.
5. Configuration and Length:
  - a. Two-Wall Tub/Shower Bar: 37" x 58".

D. Grab Bar: Swing Up w/ TPH

1. Basis-of-Design Product: Gamco, Model 125TPH.
2. Mounting: Flanges with exposed fasteners.
3. Material: Stainless steel, 0.05 inch thick.
  - a. Finish: Smooth, No. 4 finish (satin) on ends and slip-resistant texture in grip area.

4. Outside Diameter: 1-1/4 inches.
  5. Features:
    - a. Swing Up.
    - b. Toilet paper Holder.
- E. Grab Bar: Swing Up
1. Basis-of-Design Product: Gamco; Model 125.
  2. Mounting: Flanges with exposed fasteners.
  3. Material: Stainless steel, 0.05 inch thick.
    - a. Finish: Smooth, No. 4 finish (satin) on ends and slip-resistant texture in grip area.
  4. Outside Diameter: 1-1/4 inches.
  5. Features:
    - a. Swing Up.
- F. Shower Curtain Rod:
1. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; Model B-207.
  2. Outside Diameter: 1-1/4 inches.
  3. Length: As indicated on Drawings
  4. Mounting: Flanges with concealed fasteners.
  5. Rod Material and Finish: Stainless steel, No. 4 finish (satin).
  6. Flange Material and Finish: Stainless steel, No. 4 finish (satin).
  7. Accessories: Integral chrome-plated brass glide hooks.
- G. Robe Hook:
1. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; Model B-76727.
  2. Description: Double-prong unit.
  3. Material and Finish: Stainless steel, No. 4 finish (satin).
- H. Towel Bar:
1. Basis-of-Design Product: Bobrick Washroom Equipment, Inc.; Model B-673.
  2. Description: 3/4-inch- square tube with rectangular end brackets.
  3. Mounting: Flanges with concealed fasteners.
  4. Length: 24 inches.

5. Material and Finish: Stainless steel, No. 4 finish (satin).

## 2.3 CHILDCARE ACCESSORIES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  1. American Specialties, Inc.
  2. Brocar Products, Inc.
  3. Diaper Deck & Company, Inc.
  4. GAMCO Specialty Accessories; a division of Bobrick Washroom Equipment, Inc.
  5. Koala Kare Products; a division of Bobrick Washroom Equipment, Inc.
  6. SSC, Inc.
  7. Tubular Specialties Manufacturing, Inc.
- B. Diaper-Changing Station:
  1. Basis-of-Design Product: Koala Kare; Model KB200-00.
  2. Description: Horizontal unit that opens by folding down from stored position and with child-protection strap.
    - a. Engineered to support a minimum of 250-lb static load when opened.
  3. Mounting: Surface mounted, with unit projecting not more than 4 inches from wall when closed.
  4. Operation: By pneumatic shock-absorbing mechanism.
  5. Material and Finish: HDPE in manufacturer's standard color.
  6. Liner Dispenser: Built in.

## 2.4 UNDERLAVATORY GUARDS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  1. Plumberex Specialty Products, Inc.
  2. Truebro by IPS Corporation.
- B. Underlavatory Guard:
  1. Description: Insulating pipe covering for supply and drain piping assemblies that prevent direct contact with and burns from piping; allow service access without removing coverings.

2. Material and Finish: Antimicrobial, molded plastic, white.
3. Provide underlavatory guards at all exposed supply and drain piping assemblies under accessible lavatories, sinks, etc.

## 2.5 CUSTODIAL ACCESSORIES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  1. A & J Washroom Accessories, Inc.
  2. American Specialties, Inc.
  3. Bobrick Washroom Equipment, Inc.
  4. Bradley Corporation.
  5. GAMCO Specialty Accessories; a division of Bobrick Washroom Equipment, Inc.
  6. Tubular Specialties Manufacturing, Inc.
- B. Mop and Broom Holder:
  1. Basis-of-Design Product: Bobrick 'Model B-239 x 34'.
  2. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf.
  3. Length: 36 inches.
  4. Hooks: Three.
  5. Mop/Broom Holders: Four, spring-loaded, rubber hat, cam type.
  6. Material and Finish: Stainless steel, No. 4 finish (satin).
    - a. Shelf: Not less than nominal 0.05-inch- thick stainless steel.
    - b. Rod: Approximately 1/4-inch- diameter stainless steel.

## 2.6 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested according to ASTM F 446.

### **3.2 ADJUSTING AND CLEANING**

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
  - 1. For accessories that require batteries for proper operation, provide new batteries as recommended by manufacturer.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

**END OF SECTION 10 28 00**

## SECTION 10 31 00

### MANUFACTURED FIREPLACES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section includes Electric fireplace units.
- B. Related Requirements:
  - 1. Division 26 Sections for required service to electric fireplace units.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include descriptions, dimensional information, operating characteristics, fittings, accessories, and electrical requirements.
  - 1. Submit color illustration of front appearance of fireplace.
- B. Shop Drawings: Show general layout, assembly, and integration with other work.
  - 1. Include section and details of fireplace unit.

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Certification: Verification of current Underwriters Laboratories listing for models provided.

##### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fireplace units to include in operation and maintenance manuals.

#### PART 2 - PRODUCTS

##### 2.1 PERFORMANCE REQUIREMENTS

- A. Products shall bear the label of Underwriters Laboratory.

## 2.2 PRODUCTS, GENERAL

- A. Source Limitations: Obtain fireplaces as complete unit, including fittings, accessories, and anchorage devices, from single source from single manufacturer.

## 2.3 ELECTRIC FIREPLACE UNITS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Dimplex Ignite XL or comparable product by one of the following, or equal approved by the Professional:

1. Heatilator/Hearth & Home Technologies.
2. Lennox Hearth Products.
3. Majestic Products Company/Vermont Castings.

- B. Product Description:

1. XLF50: Factory built electric fireplace assembly, 15-5/8 inch high x 50-1/4 inches wide x 5-7/8 inch deep. Provide with all required electrical connections.
  - a. Resident Unit Living Rooms.
2. XLF74: Factory built electric fireplace assembly, 15-5/8 inch high x 74-1/4 inches wide x 5-7/8 inch deep. Provide with all required electrical connections.
  - a. Main Lobby.

- C. Heater Wattage: NA.

- D. BTU/Hour Output: NA.

- E. Voltage: 120 V AC, 60 Hz.

- F. Total Amps: 9.6 amp.

- G. Total Watts: 1050 watts.

- H. Heater Rating: NA.

- I. Locations: As indicated in Drawings.

## 2.4 MISCELLANEOUS MATERIALS

- A. Joint Sealant: Joint sealant complying with requirements in Section 07 92 00 "Joint Sealants".

- B. Accessories: Provide all accessories required to install operating fireplace.

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION

- A. General:

1. Install fireplace and accessories in compliance with requirements of the authority having jurisdiction.



2. Install fireplace units and all accessories where shown and according to Shop Drawings and manufacturer's written instructions.
- B. Coordinate installation with surrounding construction.
  - C. Place fireplace in position and starter section of chimney/vent in place on top of fireplace.
  - D. Frame work around the fireplace to ensure distance to combustible materials exceeds manufacturer's recommended minimum distance from side and top of opening.
  - E. Ensure that mantel is beyond manufacturer's recommended minimum distance from top of fireplace opening.

**END OF SECTION 10 31 00**

**SECTION 10 44 13**  
**FIRE PROTECTION CABINETS**

**PART 1 - GENERAL**

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

- A. Section includes fire-protection cabinets for portable fire extinguishers.
- B. Related Requirements:
  - 1. Section 07 84 13 "Penetration Firestopping" for firestopping sealants installed at perimeter of fire-rated cabinets.
  - 2. Section 10 44 16 "Fire Extinguishers."

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing recessed-, semirecessed-, or surface-mounting method and relationships of box and trim to surrounding construction.
- B. Samples: For each type of exposed finish required.
- C. Samples for Verification: For each type of exposed finish required, prepared on Samples 6 by 6 inches square.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

1.5 COORDINATION

- A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.

## 2.2 FIRE-PROTECTION CABINET

- A. Cabinet Type: Suitable for fire extinguisher.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Potter Roemer LLC; Model 1734/FRC1734 or comparable product by one of the following, or equal approved by the Professional:
    - a. JL Industries, Inc.; a division of the Activar Construction Products Group.
    - b. Larsens Manufacturing Company.
    - c. Potter Roemer LLC.
- B. Cabinet Construction: Nonrated, except where indicated or where installed in fire-rated wall construction.
  - 1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.043-inch-, 18 gage thick cold-rolled steel sheet lined with minimum 5/8-inch- thick fire-barrier material. Provide factory-drilled mounting holes.
- C. Cabinet Material: Cold-rolled steel sheet.
- D. Semirecessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
  - 1. Square-Edge Trim: 1-1/4- to 1-1/2-inch backbend depth.
- E. Cabinet Trim Material: Steel sheet.
- F. Door Material: Steel sheet.
- G. Door Style: Fully glazed panel with frame.
- H. Door Glazing: Tempered float glass (clear).
- I. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
  - 1. Provide projecting lever handle with cam-action latch.
  - 2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.
- J. Accessories:
  - 1. Lettered Door Handle: One-piece, cast-iron door handle with the word "FIRE" embossed into face.
  - 2. Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle.
  - 3. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location.
    - a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."

- 1) Location: Applied to cabinet glazing.
- 2) Application Process: Pressure-sensitive vinyl letters.
- 3) Lettering Color: As required by authorities having jurisdiction.
- 4) Orientation: Vertical.

K. Materials:

1. Cold-Rolled Steel: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
  - a. Finish: Baked enamel or powder coat.
  - b. Color: White.
2. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

## 2.3 FABRICATION

- A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
  1. Weld joints and grind smooth.
  2. Provide factory-drilled mounting holes.
  3. Prepare doors and frames to receive locks.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.
  1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
  2. Miter and weld perimeter door frames.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

## 2.4 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish fire-protection cabinets after assembly.
- D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine walls and partitions for suitable framing depth and blocking where semirecessed cabinets will be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Prepare recesses for semirecessed fire-protection cabinets as required by type and size of cabinet and trim style.

### 3.3 INSTALLATION

- A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.
- B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.
  - 1. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.
- C. Identification: Apply vinyl lettering at locations indicated.

### 3.4 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.
- E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

**END OF SECTION 10 44 13**

**SECTION 10 44 16**  
**FIRE EXTINGUISHERS**

**PART 1 - GENERAL**

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

- A. Section includes portable fire extinguishers for installation in fire-protection cabinets and mounting brackets for wall-mounted fire extinguishers.
- B. Related Requirements:
  - 1. Section 10 44 13 "Fire Protection Cabinets."

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

1.4 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.6 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:

- a. Failure of hydrostatic test according to NFPA 10.
  - b. Faulty operation of valves or release levers.
2. Warranty Period: Six (6) years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

### **2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS**

- A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by the Professional:
    - a. Amerex Corporation.
    - b. Ansul Incorporated.
    - c. JL Industries, Inc.; a division of the Activar Construction Products Group.
    - d. Kidde Residential and Commercial Division; Subsidiary of Kidde plc.
    - e. Larsens Manufacturing Company.
    - f. Potter Roemer LLC.
  2. Valves: Manufacturer's standard.
  3. Handles and Levers: Manufacturer's standard.
  4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.
- B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:80-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.
  1. Locations: Install in fire protection cabinets in corridors and where indicated on Drawings.
- C. Carbon Dioxide Type: UL-rated 5-B:C, 5-lb nominal capacity, with carbon dioxide in manufacturer's standard enameled-metal container.
  1. Locations: Install on mounting brackets in rooms and spaces with electrical equipment, elevator machine room, boiler room, mechanical rooms, electrical rooms, maintenance room, similar back-of-house spaces, and where required by authorities having jurisdiction.

### **2.3 MOUNTING BRACKETS**

- A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by the Professional:
    - a. Amerex Corporation.
    - b. Ansul Incorporated.
    - c. JL Industries, Inc.; a division of the Activar Construction Products Group.
    - d. Larsens Manufacturing Company.
    - e. Potter Roemer LLC.
- B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
  - 1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
    - a. Orientation: Vertical.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine fire extinguishers for proper charging and tagging.
  - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 INSTALLATION**

- A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
  - 1. Mounting Brackets: 54 inches above finished floor to top of fire extinguisher or at heights acceptable to authorities having jurisdiction.
- B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

**END OF SECTION 10 44 16**



## SECTION 10 51 10

### LOCKERS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Plastic-laminate-faced wood lockers.
  - 2. Locker benches.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of locker.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of locker.
  - 2. For composite wood products, include documentation indicating that products contain no added urea formaldehyde resins.
- B. Shop Drawings: For lockers.
  - 1. Include plans, elevations, sections, details, and attachments to other work.
  - 2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
  - 3. Show locker trim and accessories.
  - 4. Show locker fillers, trim, base, sloping tops, and accessories.
  - 5. Include locker identification system and numbering sequence.
- C. Samples for Verification: For locker finishes.
- D. Product Schedule: For lockers. Use same designations indicated on Drawings.

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Sample Warranty: For special warranty.

##### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

## 1.6 FIELD CONDITIONS

- A. Field Measurements: Where lockers are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicated measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
  - 1. Locate concealed framing, blocking, and reinforcements that support lockers by field measurements before being enclosed, and indicated measurements on Shop Drawings.

## 1.7 COORDINATION

- A. Coordinate sizes and locations of wood bases for metal lockers.
- B. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that lockers can be supported and installed as indicated.

## 1.8 WARRANTY

- A. Special Warranty for Plastic Laminate Lockers: Manufacturer agrees to repair or replace components of wood lockers that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures.
    - b. Faulty operation of hardware.
    - c. Deterioration of wood, wood finishes, and other materials beyond normal use.
  - 2. Warranty Period: Three years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain lockers and accessories from single source from single locker manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Accessibility Requirements: For lockers indicated to be accessible, comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.

### 2.3 PLASTIC-LAMINATE-CLAD WOOD LOCKERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Hollman, Inc.; Double-Tier, Model Z, Option 1 with base shoe cubby, Flat Panel or comparable product by one of the following, or equal approved by the Professional:
  - 1. Classic Woodworking, LLC.
  - 2. Ideal Products, Inc.
  - 3. Sports Unlimited Locker Systems.

- B. Locker Arrangement: Double-tier.
- C. Locker Size: 18 inches by 18 inches by 36 inches.
- D. Construction Style: Flush overlay.
- E. Locker Body: Fabricated from high density particleboard-core panels covered on both sides with thermos-fused melamine.
  - 1. Panels: 5/8-inch-thick.
  - 2. Exposed Panel Edges: 1-mm-thick PVC.
  - 3. Expansion/Contraction Tolerance: 1/16-inch per locker.
- F. Doors: High-pressure decorative laminate, Grade VGS, over both sides of particleboard core.
  - 1. Thickness: 5/8-inch.
  - 2. Panel Edges: Sealed with eased edge, 1.5 mm PVC edge banding to closely match laminate.
- G. Frameless Hinges (European Type): Fully concealed, nickel-plated steel, with not less than 125 degrees of opening.
  - 1. Provide two hinges for doors up to 35 inches high.
  - 2. Provide 3 hinges for doors 36 inches to 59 inches high.
  - 3. Provide 4 hinges for doors 60 inches high or more.
- H. Decorative Door Pulls:
  - 1. Material: Stainless-steel and zinc.
  - 2. Length: 500 mm.
  - 3. Location: Center of pull at 3-1/2 inches; bottom of pull at 9-12 inches.
  - 4. Product: Subject to compliance with requirements, provided Hafele America Co.; No. 115.70.006.
- I. Latch Hooks: Equip doors 48 inches and higher with three latch hooks and doors less than 48 inches high with two latch hooks; fabricated from 0.105-inch nominal thickness steel sheet; welded or riveted to full-height door strikes; with resilient silencer on each latch hook.
- J. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating a pre-locking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.
- K. Locks: Keyless security lock; Hollman, Inc. part number KSL21772; when lock is open, users can spin the four dials to select their combination; wireless; using no batteries.
- L. Identification Plates: Manufacturer's standard etched, embossed, or stamped aluminum plates, with numbers and letters minimum 3/8-inch high.
- M. Hooks: Manufacturer's standard ball-pointed type hooks, aluminum or steel; zinc plated.
  - 1. Provide one double-prong ceiling hook and two single-prong wall hooks for each compartment.
- N. End Panels: Plastic laminate cladding on 3/4-inch thick particleboard.
- O. Corner and Filler Panels: Plastic laminate cladding on 3/4-inch thick particleboard.
- P. Base Shoe Cubby: Minimum 11" high by width by length of the locker. Plastic laminate cladding on 3/4-inch thick particleboard.

- Q. Materials:
1. Composite Wood: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.
  2. Particleboard: ANSI A208.1, Grad M-2, made with binder containing no added urea formaldehyde resins.
  3. Thermoset Decorative Panels: Particleboard or medium-density fiberboard finished with thermally-fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade BGL, for Test Methods 3.3, 3.4, 3.6, 3.8, and 3.10.
  4. High-Pressure Decorative Laminate: NEMA LD3, grades as follows:
    - a. Horizontal Surfaces: Grade HGS.
    - b. Postformed Surfaces: Grade HGP.
    - c. Vertical Surfaces: Grade HGS.
    - d. Color: As indicated on Drawings.
  5. Furring, Blocking, Shims, and Hanging Strips: As specified in Section 06 10 53 "Miscellaneous Rough Carpentry."
  6. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

#### 2.4 PLASTIC-LAMINATE-FACED WOOD LOCKER FABRICATION

- A. Fabricate each locker with shelves, an individual door and frame, an individual top, a bottom, and a back, and with common intermediate uprights separating compartments.
1. Fabricate lockers to dimensions, profiles, and details indicated.
  2. Ease edges of corner of solid-wood members to 1/16-inch radius.
- B. Fabricate components square, rigid, without warp, and with finished faces flat and free of scratches and chips. Accurately factory machine components for attachments. Make joints tight and true.
1. Fabricate lockers using manufacturer's standard construction, with joints made with dowels, dados, or rabbets. Dado side panels to receive shelving except where indicated to be adjustable.
  2. Fabricate lockers with joints that are dadoed or rabbeted, glued full length, and stapled. Dado side panels to receive shelving except where indicated to be adjustable.
- C. Accessible Lockers: Fabricate as follows:
1. Locate bottom shelf no lower than 15 inches above the floor.
  2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches above the floor.
- D. Venting: Fabricate lockers with space between doors and locker assembly of not less than ¼ inch.
- E. Number Plates: Inlay number plates flush in each locker door, near top, centered.
- F. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible, before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended, and check

measurements of assemblies against filed measurements indicated on Shop Drawings before disassembling for shipment.

- G. Shop cut openings, to maximum extent possible, to receive hardware and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine walls, floors, and support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Condition lockers to average prevailing humidity conditions in installation areas before installation.
- B. Before installing lockers, examine factory-fabricated work for completeness and complete work as required, including removal of packing.

### 3.3 METAL LOCKER INSTALLATION

- A. General: Install lockers level, plumb, and true; shim as required, using concealed shims.
  - 1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches o.c. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
  - 2. Anchor single rows of metal lockers to walls near top and bottom of lockers.
  - 3. Anchor back-to-back metal lockers to floor.
- B. Knocked-Down Lockers: Assemble with standard fasteners, with no exposed fasteners on door faces or face frames.
- C. Equipment:
  - 1. Attach hooks with at least two fasteners.
  - 2. Attach door locks on doors using security-type fasteners.
  - 3. Identification Plates: Identify metal lockers with identification indicated on Drawings.
    - a. Attach plates to each locker door, near top, centered, with at least two aluminum rivets.
- D. Trim: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.
  - 1. Attach filler panels with concealed fasteners. Locate filler panels where indicated on Drawings.
  - 2. Attach sloping-top units to metal lockers, with closures at exposed ends.

3. Attach boxed end panels using concealed fasteners to conceal exposed ends of nonrecessed metal lockers.

#### 3.4 PLASTIC-LAMINATE-FACED WOOD LOCKER INSTALLATION

- A. Assemble knocked-down wood lockers with manufacturer's standard fasteners, with no exposed fasteners on face frames.
- B. Install wood lockers level, plumb, and true; use concealed shims.
- C. Connect groups of wood lockers together with manufacturer's standard fasteners through predrilled holes, with no exposed fasteners on face frames. Fit wood lockers accurately together to form flush, tight, hairline joints.
- D. Install wood lockers without distortion so doors fit openings properly and are accurately aligned. Adjust hardware to center doors in openings, providing unencumbered operation. Complete installation of hardware and accessory items as indicated.
  1. Installation Tolerance: No more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line. Shim as required with concealed shims.
  2. Maintain veneer sequence matching of wood-faced wood lockers.
- E. Locker Anchorage: Fasten wood lockers through back, near top and bottom, at ends with No. 8 flush-head wood screws sized for 1-inch penetration into wood framing, blocking, or furring.
- F. Scribe and cut corner and filler panels to fit adjoining work using fasteners concealed where practical. Repair damaged finish at cuts.
- G. Attach sloping-top units to wood lockers, with end panels covering exposed ends.
- H. Install number plates after wood lockers are in place.
  1. Attach number plate on each wood locker door, near top, centered, with at least two screws with finish matching number plate.

#### 3.5 LOCKER BENCH INSTALLATION

- A. Fixed Locker Benches: Provide no fewer than two pedestals for each bench, uniformly spaced not more than 72 inches apart. Securely fasten tops of pedestals to undersides of bench tops, and anchor bases to floor.
- B. Freestanding Locker Benches: Place benches in locations indicated on Drawings.

#### 3.6 ADJUSTING

- A. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding. Verify that integral locking devices operate properly.

#### 3.7 PROTECTION

- A. Protect lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.

- B. Touch up marred finishes, or replace metal lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION 10 51 19

## SECTION 10 55 00.13

### USPS-DELIVERY POSTAL SPECIALTIES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Collection boxes.
- B. Related Requirements:
  - 1. Section 08 71 00 "Door Hardware" for lock cylinders for postal specialties that are keyed to building keying system and for letter slots in doors.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of postal specialty.
- B. Shop Drawings: For postal specialties. Include plans, elevations, sections, and attachment details.
  - 1. Include identification sequence for compartments.
  - 2. Include layout of identification text.
  - 3. Include setting drawings, templates, and installation instructions for anchor bolts and other anchorages installed as part of the Work of other Sections.
- C. Samples: For units with factory-applied color finishes.
- D. Samples for Verification: For each type of exposed finish, prepared on 6-by-6-inch square Samples.

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of postal specialty required to comply with USPS regulations, signed by product manufacturer. Include written approval by Postmaster General.
- B. Sample Warranty: For special warranty.

##### 1.5 CLOSEOUT SUBMITTALS



- A. Maintenance Data: For postal specialties and finishes to include in maintenance manuals.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Furnish lock keys according to USPS requirements; with temporary identification for their respective locks, bagged, and securely taped inside the collection compartment for shipping.

## 1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of postal specialties that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
  - a. Structural failures.
  - b. Faulty operation of hardware.
  - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
2. Warranty Period: Five (5) years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 COLLECTION BOXES

- A. Front-Loading Collection Boxes: Consisting of single compartment with fire-resistant cushion bottom, enclosed within wall box, with mail slot to receive mail. Provide door for collecting mail from front of unit.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by the Professional:
  - a. Bommer Industries, Inc.
  - b. Florence Corporation; a Gibraltar Industries company.
  - c. Jensen Mailboxes; SCC Architectural Building Products.
  - d. Salsbury Industries.
  - e. Security Manufacturing Corporation.
2. Mounting: Recessed.
3. Height: As indicated on Drawings.
4. Compartment Doors and Frames: Fabricated from 1/4-inch- thick aluminum, with opening not less than 12 by 20 inches and not more than 18 by 30 inches. Equip door with lock and concealed, full-length, flush hinge on one side.
  - a. Door Lock: Door prepared to receive lock provided by local postmaster.
  - b. Identification: Engrave face of compartment door with 1-inch- high letters as follows: "U.S. MAIL LETTER BOX" on two lines at top or bottom of unit.
  - c. Door Style: Set door within face frame.

5. Mail Slot: Fabricated from 1/4-inch- thick aluminum, with 11-inch-wide by 1-1/4-inch- high opening, protected by inside hood and hinge flap, and with inside baffle to prevent removal of mail from box.
6. Exposed Materials: Fabricated from extruded or sheet aluminum.
  - a. Baked-Enamel or Powder-Coated Finish: Color as selected by Architect from manufacturer's full range.
7. Concealed Components and Mounting Frames: Aluminum or steel sheet.
8. Schedule-Card Holder: Recessed or surface-mounted holder for pickup schedule card in center of bottom front portion of unit. Same material and finish as front of unit.
9. Mailbag Hooks: Two aluminum or stainless-steel hooks at exterior front edge of bottom of surface-mounted units, spaced 15 to 17-1/2 inches apart, for supporting mailbags.
10. Mailbag Rack: Internal rack system for supporting mailbags within unit.

## 2.2 FABRICATION

- A. Form postal specialties to required shapes and sizes, with true lines and angles, square, rigid, and without warp, and with metal faces flat and free of dents or distortion. Make exposed metal edges and corners free of sharp edges and burrs and safe to touch. Fabricate doors of postal specialties to preclude binding, warping, or misalignment.
- B. Preassemble postal specialties in shop to greatest extent possible to minimize field assembly.
- C. Mill joints to a tight, hairline fit. Cope or miter corner joints. Form joints exposed to weather to exclude water penetration.
- D. Drill or punch holes required for fasteners and remove burrs. Use security fasteners where fasteners are exposed. If used, seal external rivets before finishing.
- E. Weld in concealed locations to greatest extent possible without distorting or discoloring exposed surfaces. Remove weld spatter and welding oxides from exposed surfaces.
- F. Fabricate tubular and channel frame assemblies with manufacturer's standard welded or mechanical joints. Provide subframes and reinforcement as required for a complete system to support loads.
- G. Where dissimilar metals contact each other, protect against galvanic action by painting contact surfaces with bituminous coating or by applying other permanent separation as recommended by manufacturers of dissimilar metals.

## 2.3 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM/NOMMA's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions for compliance with requirements for roughing-in openings, clearances, and other conditions affecting performance of the Work.
- B. Examine walls and other adjacent construction for suitable conditions before installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Install postal specialties level and plumb, according to manufacturer's written instructions.
  - 1. Where dissimilar metals contact each other, protect against galvanic action by painting contact surfaces with bituminous coating or by applying other permanent separation as recommended by manufacturer.
  - 2. Where aluminum contacts grout, concrete, masonry, or wood, protect against corrosion by painting contact surfaces with bituminous coating.
  - 3. Final acceptance of postal specialties served by the USPS depends on compliance with USPS requirements.
- B. Mail Receptacles: Install mail receptacles with center of tenant-door lock cylinders and bottom of compartments at the maximum and minimum heights above finished floor established by the USPS and manufacturer's written instructions.
  - 1. Install removable-core and keyed-in door lock cylinders as required for each type of cylinder lock.
- C. Collection Boxes: Install collection boxes with centerline of mail slots not more than 48 inches above finished floor.

### **3.3 FIELD QUALITY CONTROL**

- A. Arrange for USPS personnel to examine and test postal specialties served by the USPS after they have been installed according to USPS regulations.

### **3.4 ADJUSTING AND CLEANING**

- A. Remove temporary protective coverings and strippable films, if any, as postal specialties are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust doors, hardware, and moving parts to function smoothly, and lubricate as recommended by manufacturer. Verify that integral locking devices operate properly.
- C. Touch up marred finishes or replace postal specialties that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by postal-specialty manufacturer.

- D. Replace postal specialties that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.
- E. On completion of postal-specialty installation, clean interior and exterior surfaces as recommended by manufacturer.

**END OF SECTION 10 55 00.13**

## SECTION 105626 - MOBILE STORAGE SHELVING

### PART 1 - GENERAL

#### 1.1 STIPULATIONS

1.2 The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

#### 1.3 SUMMARY

A. Section Includes:

1. Mechanically assisted systems.
2. Steel-bracket shelving.
3. Steel-case shelving.
4. Steel four-post shelving.

B. Products Furnished But Not Installed Under This Section:

1. Inserts in cast-in-place concrete.

C. Related Requirements:

1. Section 035416 "Hydraulic Cement Underlayment" for leveling of floor where recessed tracks are installed.

#### 1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

#### 1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include mobile operation, construction details, material descriptions, dimensions of individual components and profiles, and finishes for mobile storage shelving systems and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Show shelving layout.
3. Show location and extent of rail system.
4. Show clear-aisle widths from face of carriages.
5. Detail fabrication and installation of mobile shelving systems including methods of anchoring shelves to carriages and rails to building structure.

C. Samples: For each exposed product and for each color and texture specified, 6 inches in size.

- D. Samples for Verification: For the following products, one of each, in manufacturer's standard size:
  - 1. Flat shelving.
  - 2. Each type of specialized shelving.
  - 3. Front panels.
- E. Delegated-Design Submittal: For mobile storage shelving, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturer.
- B. Sample Warranty: For manufacturer's special warranty.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For mobile shelving systems and operating manuals to include in maintenance manuals.

#### 1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer capable of fabricating mobile storage shelving that meets or exceeds performance requirements indicated and of documenting this performance by test reports, and calculations.
- B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

#### 1.9 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of support rail anchors, depressed slab, embedded conduit, and other construction contiguous with mobile storage shelving by field measurements before fabrication.

#### 1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of mobile shelving systems that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Deterioration of metals, metal finishes, and other materials beyond normal wear.
  - 2. Warranty Period: Ten years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain mobile storage systems including shelving from single manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Delegated-Design Submittal: For mobile storage shelving, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- B. Structural Performance: Provide mobile shelving systems capable of supporting the following:
  - 1. Load per Linear Foot of Carriage: 1000 lb/ft.
- C. Operating Force: For manually operated systems, maximum 1 lbf required to move 1000 lb.

### 2.3 SYSTEMS AND COMPONENTS

- A. General: Provide manufacturer's standard mobile storage shelving systems and components. Where components are not otherwise indicated, provide manufacturer's standard components as required for a complete system.
- B. Inserts: Furnish required concrete inserts and similar anchorage devices for installing track system, and furnish other components of work where installation of devices is specified in another Section.
- C. Flooring: Underlayment thickness required to bring aisle floor finish flush with rail tops.
  - 1. Plywood Underlayment: DOC PS 1, Interior, Underlayment.
    - a. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84.
  - 2. Ramps: Manufacturer's standard metallic-coated, cold-rolled steel ramp not steeper than 1:12, with non-slip finish.
  - 3. Floor Finish: Manufacturer's standard 12-inch-square vinyl tile; color as selected by Architect from manufacturer's full range.
- D. Tracks: Steel rails with tops machined to mate with guide wheels and with ends designed to provide smooth, secure continuity between sections without field welding. Provide mounting brackets, anchorage devices, adjustable leveling devices, and stops at terminations of rails to prevent carriages from running off track ends.
  - 1. Mounting: Surface Mounted.
- E. Carriages: Rigid frames consisting of C-shaped cold-formed steel beams and cross beams, designed to allow secure anchorage of shelving units.
  - 1. Carriage Width: 9'-0", as indicated on Drawings.
  - 2. Carriage Length: 12'-0", as indicated on Drawings.
  - 3. Wheels: Manufacturer's standard number of bearing-mounted, steel wheels, precision ground to mate with tracks.
  - 4. Bumpers: Provide two rubber bumpers with minimum depth of 1/2 inch each side.

- F. Carriage End Panels: Full depth and height of shelving units. Provide at both ends of each range.
  - 1. Material: high-pressure decorative laminate.

## 2.4 MECHANICALLY ASSISTED SYSTEMS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Space Saver Corporation; 4 Post / Case-Type Shelving or comparable product by one of the following, or equal approved by Professional:
  - 1. Safeco.
  - 2. Southwest Solutions Group.
  - 3. Hi-Density Space Saving Systems.
  - 4. TAB Storage Solutions
  - 5. Egipto
- B. Drive Systems: Geared transmission and chain systems with tensioning device to provide mechanical assistance and uniform movement along entire length of each carriage. Permanently shielded and lubricated.
- C. Drive Shaft: Continuous tubular or solid steel shaft, capable of transmitting torque from drive system without distortion.
- D. Locking Pins: Located on range end panels to allow locking of individual range carriage when depressed.

## 2.5 STEEL FOUR-POST SHELVING

- A. Steel Four-Post Shelving: Shelving consisting of four angle-iron uprights per section, with adjustable shelves resting on shelf supports hung on uprights. Configure units for mounting on mobile carriages.
- B. Shelving Units:
  - 1. Type: Self-supporting unit.
  - 2. Configuration: Open front and back.
  - 3. Width: 36 inches.
  - 4. Height: 76 inches.
  - 5. Shelf Depth: 24 inches nominal.
  - 6. Shelf Styles: Provide the following styles and numbers of adjustable shelves:
    - a. Flat; six shelves.
    - b. Adjustable divider; six shelves. Provide five adjustable partitions per shelf with hooks or tabs to fit in slots in divider shelves.
    - c. Metal shelves.
- C. Uprights: Double-wall steel posts, 2 inches wide, 0.048 inch thick, in manufacturer's standard T-shape for common-post use or L-shape at range ends, with keyhole perforations on the inner wall at 1-1/2 inches o.c.
- D. Steel Spacers: Provide 0.048-inch- thick steel spacers, 3 inches high, welded to posts at bottom, center, and top of open units to prevent deflection.



- E. Base: Manufacturer's standard for attachment to mobile carriages.
- F. Adjustable Steel Shelves: 0.030-inch-thick cold-rolled steel sheet.
  - 1. Shelf Supports: Full-shelf-width supports; 0.075-inch-thick steel, minimum 3/4 inches high, with flange to support shelf reinforcements and with ear at each end containing two shoulder rivets with 7/16-inch heads spaced to set into keyhole slots on uprights.
  - 2. Shelf Reinforcements: Channel shapes equal in length to depth of the supported shelf; 0.060-inch-thick steel channels, with notched ends to fit over inside lip of shelf support.

## 2.6 MATERIALS

- A. High-Pressure Decorative Laminate: NEMA LD 3, Grade VGS.
  - 1. Colors, Textures, and Patterns: As selected by Architect from manufacturer's full range.

## 2.7 STEEL FINISHES

- A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- B. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to achieve a minimum dry film thickness of 2 mils.
  - 1. Color and Gloss: As selected by Architect from manufacturer's full range.

## 2.8 SYSTEM ACCESSORIES

- A. Floor Lock: Key-operated floor lock capable of securing entire system. Provide two keys.
- B. Aisle Lights: Manufacturer's standard aisle lighting system that automatically turns on when aisle is open and shuts off when aisle is closed. Provide one light unit per aisle.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of framing and reinforcements, minimum recess depth, and other conditions affecting performance of mobile shelving systems.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Level and plumb tracks to a tolerance of 0.09 inch in 120 inches with no more than 0.06-inch variation between adjacent rails. Use permanent shims or non-shrink grout as indicated by manufacturer.
- B. Surface-Mounted Track Systems: Install underlayment, ramps, and finish flooring according to manufacturer's written instructions and flush with track surfaces. Do not extend ramps beyond ends of carriages.

### 3.3 SHELVING INSTALLATION

- A. Attach shelving units to carriages according to manufacturer's written instructions and as required to prevent vibration during movement.
  - 1. Level and plumb shelving units to a tolerance of 1/8 inch in 96 inches.
- B. Starter/Adder Units: Connect groups together with standard fasteners according to manufacturer's written instructions, using concealed fasteners where possible.
- C. Install shelves in shelving units at locations indicated on Drawings and according to manufacturer's written instructions.
- D. Shelving Enclosure Panels: Install end panels and canopy tops with concealed fasteners.

### 3.4 CLEANING AND PROTECTING

- A. Repair or remove and replace defective work as directed on completion of installation.
- B. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.
- C. Protect installed products from damage during remainder of the construction period.

### 3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain mobile storage shelving.

**END OF SECTION 10 56 26**

## SECTION 107300

### EXTRUDED ALUMINUM WALKWAY COVERS

#### PART 1 GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 DESCRIPTION OF WORK:

- A. The extent of aluminum walkway cover is shown on the drawings and as specified herein.
- B. Definition: Extruded Aluminum Walkway Cover shall consist entirely of extruded aluminum sections (roll-formed not acceptable). System shall consist of heli-arc welded, one-piece rigid structural bents (column and beam assemblies), decking, fascia, accessory items and hardware to provide a complete system.
- C. Water shall drain from deck into designated beams and out at grade level of columns through weepholes.

##### 1.3 SUBMITTALS

- A. Shop Drawings: Submit detailed drawings, layout of walkway cover system, bent locations (identify drain columns and wet bents), all mechanical joint locations with complete details, connections, jointing and accessories. Include details of concrete footings and bent anchorage.
- B. Product Data: Submit manufacturer's product data, specifications, component performance data and installation instructions.
- C. Delegated Design: Engage a qualified professional engineer, licensed in the Commonwealth of Pennsylvania, to design aluminum-framed entrances and storefronts.

##### 1.4 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of the following except as otherwise indicated.
  - 1. Standard Building Code, latest addition with amendments, if any.
  - 2. AWS (American Welding Society) standards for structural aluminum welding.
- B. Manufacturer: Obtain aluminum covered walkway system from only one (1) manufacturer, although several may be indicated as offering products complying with requirements.
- C. Installer Qualification: Firm with not less than three (3) years' experience in installation of aluminum walkway covers of type, quantity and installation methods similar to work of this section.

- D. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication where possible, to insure proper fitting of work. However, allow for adjustments within specified tolerations wherever taking of field measurements before fabrication might delay work.
- E. Shop Assembly: Pre-assemble units in shop to greatest extent possible and disassemble as necessary for shipping and handling limitations. Clearly mark units for re-assembly and coordinated installation.
- F. Coordination: Coordinate work of this section with work of other sections which interface with covered walkway system. (sidewalks, curbs, building fascias, etc.).

1.5 PERFORMANCE REQUIREMENTS:

- A. System Performance: Provide aluminum covered walkway system that has been designed, produced, fabricated, and installed to withstand normal temperature changes as well as live loading, dead loading and wind loading in compliance with Standard Building Code requirements for geographic area in which work is located.
- B. Sizes shown on drawings are to be considered minimum.
- C. Structure shall be capable of sustaining severe icing, hail, hurricane force winds and supporting a concentrated load such as being walked upon.

**PART 2 PRODUCT**

2.01 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Dittmer Architectural Aluminum, Ditt-Deck or comparable product by one of the following, or equal approved by Professional:
  - 1. Peachtree Protective Covers.
  - 2. Tennessee Valley Metals, Inc.
  - 3. Mitchell Metals.
  - 4. Bonnell Aluminum
  - 5. Perfection Architectural Systems, LLC

2.02 MATERIALS

- A. All aluminum extrusions shall be alloy 6063 heat treated to a T-6 temper.
- B. Standard finish for all components shall be satin anodize meeting Aluminum Association Specification AA-M-10C-22A-21 minimum.
- C. Fasteners:
  - 1. Deck Screws (rivets not permitted): Type 18-8 non-magnetic stainless steel sealed with a neoprene "O" ring beneath 5/8" outside dimension, conical washer.
  - 2. Fascia Rivets: Size 3/16" by 1/2" grip range aluminum rivets with aluminum mandrel.
  - 3. Bolts: All bolts, nuts and washers to be 18-8 non-magnetic stainless steel.
  - 4. Tek Screws: not permitted.
- D. Warranty:

1. Manufacturer shall warrant the entire system against defects in labor and materials for a period of FIVE (5) years commencing on the date of substantial completion as established in Division One of these specifications.
2. Intention of this warranty is the manufacturer will come onto the jobsite and do all necessary to effect corrections of any deficiencies.
3. Prima Facie Evidence of defects in labor and material may include but is not limited to, one or more of the following:
  - a. Moisture Leaks
  - b. Metal failure including excessive deflection
  - c. Fastener failure
  - d. Finish failure

## 2.03 ALUMINUM FINISHES

- A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
  1. Color and Gloss: As selected by Architect from manufacturer's full range.

## FABRICATION

- A. Comply with indicated profiles, dimensional requirements and structural requirements.
- B. Use sections true to details with clean, straight sharply defined profiles and smooth surfaces of uniform color and texture, free from defects impairing strength and durability.
- C. All welding to be done by heli-arc process.
- D. Bents shall consist of shop welded one-piece units. When size of bents do not permit shipment as a welded unit, concealed mechanical joints may be used.
- E. Mechanical joints shall consist of stainless-steel bolts with a minimum of two (2) bolts per fastening. Bolts and nuts shall be installed in a concealed manner utilizing ½" thick by 1 ½" aluminum bolt bars welded to structural members. All such mechanical joints must be detailed on shop drawings showing all locations.
- F. Roof Deck: Extruded aluminum shapes, interlocking self-flashing sections. Shop fabricate to lengths and panel widths required for field assembly. Depth of sections to comply with structural requirements. Provide shop induced camber in deck units with spans greater than 16'-0" to offset dead load deflections. Internal dams are to be used at non-draining ends of deck.
- G. Expansion joints, design structure for thermal expansion and contraction. Provide expansion joints as required.
- H. Exposed rivets used to fasten bottom of fascia to deck to have finish to match fascia.
- I. Apply a shop applied dip-coat of clear acrylic enamel to each column end terminating in concrete to insulate from electrolytic reaction. Column ends shall be pierced to "key" grout to bent for maximum uplift protection.

## PART 3 EXECUTION

### 3.01 DELIVERY, STORAGE AND HANDLING:

- A. Deliver, store and handle covered walkway system components as recommended by manufacturer. Handle and store in a manner to avoid deforming members and to avoid excessive stresses.

### 3.02 EXAMINATION

- A. Examine adjacent work for conditions that would prevent quality installation of system.
- B. Do not proceed until defects are corrected.

### 3.03 CONCRETE FOOTINGS

- A. Concrete footings are not work of this section. Refer to "concrete work", Section 03310.
- B. Sleeves (styrofoam blockouts) shall be furnished by walkway cover manufacturer and placed by general contractor.

### 3.04 FIELD DIMENSIONS

- A. General contractor shall field confirm bent locations, dimensions and elevations shown on shop drawings prior to fabrication.

### 3.05 INSTALLATION

- A. Erection: Set roof support frames (bents) into pockets provided in top of footings; set to required elevations, align, plumb, and level; and grout in place with 2,000 p.s.i. portland cement grout. Assure that grout fills all voids and "keys" to columns. Fill downspout units with grout to bottom of discharge level. Install aluminum deflectors after grouting. Follow manufacturer's instructions. Match to finish and elevation of adjacent sidewalks.
- B. Install roof deck sections, accessories and related flashing in accordance with manufacturer's instructions. Provide roof slope for rain drainage without ponding water. Align and anchor roof deck units to structural support frames.
- C. Assemble all components in a neat, workmanlike manner.

### 3.06 FLASHING

- A. Flashings: Flashing required between covered walkway system and adjoining structures are not work of this section. Refer to "Flashing and Sheet Metals", Section 07600.

### 3.07 CLEANING AND PROTECTION

- A. Damaged Units: Replace roof deck panels and other components of the work which have been damaged or have deteriorated beyond successful minor repair.
- B. Cleaning: Remove protective coverings at time in project construction sequence which will afford greatest protection of work. Clean finished surfaces as recommended by manufacturer. Maintain in a clean condition during construction.

- C. Protection: Advise Contractor of protection and surveillance procedures, as required to ensure that work of this section will be without damage or deterioration at time of substantial completion.

**END OF SECTION 10 73 00**

**SECTION 10 75 16**  
**GROUND-SET FLAGPOLES**

**PART 1 - GENERAL**

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

- A. Section includes ground-set flagpoles made from aluminum.
- B. Owner-Furnished Material: Flags.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, operating characteristics, fittings, accessories, and finishes for flagpoles.
- B. Shop Drawings: For flagpoles.
  - 1. Include plans, elevations, and attachment details. Show general arrangement, jointing, fittings, accessories, grounding, anchoring, and support.
- C. Include section, and details of foundation system.
- D. Samples for Verification: For each type of exposed finish, in manufacturer's standard sizes.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flagpoles to include in operation and maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Spiral wrap flagpoles with heavy paper and enclose in a hard fiber tube or other protective container.



## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain flagpoles as complete units, including fittings, accessories, bases, and anchorage devices, from single source from single manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Flagpole assemblies, including anchorages and supports, shall withstand design loads indicated within limits and under conditions indicated.
  - 1. Wind Loads: Determine according to NAAMM FP 1001. Basic wind speed for Project location is 120 mph.
  - 2. Base flagpole design on polyester flags of maximum standard size suitable for use with flagpole or flag size indicated, whichever is more stringent.

### 2.3 ALUMINUM FLAGPOLES

- A. Aluminum Flagpoles: Cone-tapered flagpoles fabricated from seamless extruded tubing complying with ASTM B 241/B 241M, Alloy 6063, with a minimum wall thickness of 3/16 inch.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by the Professional:
    - a. Acme/Lingo Flagpoles LLC.
    - b. American Flagpole; a Kearney-National Inc. company.
    - c. Baartol Company.
    - d. Eder Flag Manufacturing Company, Inc.
    - e. Ewing Flagpoles.
    - f. Morgan-Francis Flagpoles and Accessories.
    - g. Pole-Tech Company Inc.
- B. Exposed Height: 25 feet for American flag, 20 feet for other flags.
- C. Diameter: 6" Base and 3.5" at top.
- D. Wall Thickness: .156" minimum
- E. Metal Foundation Tube: Manufacturer's standard corrugated-steel foundation tube, 0.060-inch (1.52-mm) wall thickness with 3/16-inch (4.8-mm) steel bottom plate and support plate; 3/4-inch- (19-mm-) diameter, steel ground spike; and steel centering wedges welded together. Galvanize foundation tube after assembly. Furnish loose hardwood wedges at top of foundation tube for plumbing pole.
- F. Construct flagpoles in one piece if possible. If more than one piece is necessary, comply with the following:
  - 1. Fabricate shop and field joints without using fasteners, screw collars, or lead calking.
  - 2. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.
- G. Sleeve for Aluminum Flagpole: Fiberglass or PVC pipe foundation sleeve, made to fit flagpole, for casting into concrete foundation.

1. Flashing Collar: Same material and finish as flagpole.

## 2.4 FITTINGS

- A. Finial Ball: Flush-seam ball, sized as indicated or, if not indicated, to match flagpole-butt diameter.
  1. 0.063-inch spun aluminum with gold anodic finish.
- B. External Halyard: Ball-bearing, nonfouling, revolving truck assembly of cast metal with continuous 5/16-inch- diameter, braided polypropylene halyard and 9-inch cast-metal cleats with fasteners. Finish exposed metal surfaces to match flagpole.
  1. Halyards and Cleats: One at each flagpole.
  2. Cleat Covers: Cast metal, finished to match flagpole, secured with cylinder locks.
  3. Halyard Flag Snaps: Stainless-steel swivel snap hooks with neoprene or vinyl covers. Furnish two per halyard.

## 2.5 MISCELLANEOUS MATERIALS

- A. Sand: ASTM C 33/C 33M, fine aggregate.
- B. Drainage Material: Crushed stone, or crushed or uncrushed gravel; coarse aggregate.
- C. Elastomeric Joint Sealant: Multicomponent nonsag urethane joint sealant complying with requirements in Section 07 92 00 "Joint Sealants."
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

## 2.6 ALUMINUM FINISHES

- A. Natural Satin Finish: AA-M32, fine, directional, medium satin polish; buff complying with AA-M20; seal aluminum surfaces with clear, hard-coat wax.

# PART 3 - EXECUTION

## 3.1 PREPARATION

- A. Foundation Excavation: Excavate to neat clean lines in undisturbed soil. Remove loose soil and foreign matter from excavation and moisten earth before placing concrete. Place and compact drainage material at excavation bottom.
- B. Provide forms where required due to unstable soil conditions and for perimeter of flagpole base at grade. Secure and brace forms to prevent displacement during concreting.
- C. Foundation Tube: Place foundation tube, center, and brace to prevent displacement during concreting. Place concrete. Plumb and level foundation tube and allow concrete to cure.
- D. Sleeves: Locate and secure sleeves in forms by bracing to reinforcement and forms.

- E. Place concrete, as specified in Section 03 30 00 "Cast-in-Place Concrete." Compact concrete in place by using vibrators. Moist-cure exposed concrete for no fewer than seven days or use nonstaining curing compound.
- F. Trowel exposed concrete surfaces to a smooth, dense finish, free of trowel marks, and uniform in texture and appearance. Provide positive slope for water runoff to perimeter of concrete base.

### 3.2 FLAGPOLE INSTALLATION

- A. General: Install flagpoles where indicated and according to Shop Drawings and manufacturer's written instructions.
- B. Foundation Tube: Place flagpole in tube, seated on bottom plate between steel centering wedges, and install hardwood wedges to secure flagpole in place. Place and compact sand in foundation tube and remove hardwood wedges. Seal top of foundation tube with a 2-inch layer of elastomeric joint sealant and cover with flashing collar.

**END OF SECTION 10 75 16**

## SECTION 11 13 13

### LOADING DOCK BUMPERS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section includes loading dock bumpers.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of loading dock bumper.
- B. Shop Drawings: For dock bumpers. Include plans, elevations, sections, details, and attachments to other work.

#### PART 2 - PRODUCTS

##### 2.1 DOCK BUMPERS

- A. General: Surface-mounted bumpers; of type, size, and construction indicated; designed to absorb kinetic energy and minimize damage to loading dock structure.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by the Professional:
    - a. American Floor Products Company, Inc.
    - b. Beacon Industries, Inc.
    - c. Chalfant Sewing Fabricators, Inc.
    - d. Durable Corporation.
    - e. Hugger Dock Equipment Company.
    - f. Kelley; 4Front Engineered Solutions, Inc.
    - g. Pioneer Dock Equipment.
    - h. Rite-Hite Holding Corporation.
    - i. Rotary Products Inc.
    - j. Serco; 4Front Engineered Solutions, Inc.
    - k. Super Seal Mfg. Ltd.
    - l. Vestil Manufacturing Corp.
- B. Laminated-Tread Dock Bumper: Fabricated from multiple, uniformly thick plies cut from fabric-reinforced rubber tires. Laminate plies under pressure on not less than two 3/4-inch- diameter,

steel supporting rods that are welded at one end to 1/4-inch- thick, structural-steel end angle and secured with a nut and angle at the other end. Fabricate angles with predrilled anchor holes and sized to provide not less than 1 inch of tread plies extending beyond the face of closure angles.

1. Thickness: 6 inches.
  2. Horizontal Style: 10 inches high by length indicated on Drawings.
  3. Vertical Style: 8 inches wide by 24 inches high.
- C. Anchorage Devices: Galvanized-steel anchor bolts, nuts, washers, bolts, sleeves, cast-in-place plates, and other anchorage devices as required to fasten bumpers securely in place and to suit installation type indicated. Hot-dip galvanized according to ASTM A 153/A 153M or ASTM F 2329.
- D. Materials: ASTM 36/A 36M for steel plates, shapes, and bars. Hot-dip galvanize according to ASTM A 123/A 123M.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 INSTALLATION**

- A. Dock Bumpers: Attach dock bumpers to face of loading dock in a manner that complies with requirements indicated for spacing, arrangement, and position relative to top of platform and anchorage.
  1. Welded Attachment: Plug-weld anchor holes in contact with steel inserts and fillet weld at other locations.
  2. Bolted Attachment: Attach dock bumpers to preset anchor bolts embedded in concrete or to cast-in-place inserts or threaded studs welded to embedded-steel plates or angles. If preset anchor bolts, cast-in-place inserts, or threaded studs welded to embedded-steel plates or angles are not provided, attach dock bumpers by drilling and anchoring with expansion anchors and bolts.
  3. Screw Attachment: Attach dock bumpers to wood construction with lag bolts as indicated.

#### **3.3 ADJUSTING**

- A. After completing installation of exposed, factory-finished dock bumpers, inspect exposed finishes and repair damaged finishes.

**END OF SECTION 11 13 13**

## SECTION 11 13 19

### STATIONARY LOADING DOCK EQUIPMENT

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:

- 1. Recessed loading dock levelers.

- B. Related Requirements:

- 1. Section 055000 "Metal Fabrications" for curb angles at edges of recessed pits and [loading dock platform edge channels.
  - 2. Section 111313 "Loading Dock Bumpers" for loading dock bumpers that are not integral with loading dock levelers.

##### 1.3 DEFINITIONS

- A. Operating Range: Maximum amount of travel above and below the loading dock level.
- B. Working Range: Recommended amount of travel above and below the loading dock level for which loading and unloading operations can take place.

##### 1.4 COORDINATION

- A. Coordinate size and location of loading dock equipment indicated to be attached to or recessed into concrete or masonry, and furnish anchoring devices with templates, diagrams, and instructions for their installation
- B. Coordinate installation of cast-in-place items. Furnish setting drawings and templates.
- C. Electrical System Roughing-in: Coordinate layout and installation of loading dock equipment with connections to power supplies.

##### 1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Z Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors.
2. Inspect and discuss electrical roughing-in, equipment bases, and other preparatory work specified elsewhere.
3. Review sequence of operation for each type of loading dock equipment.
4. Review coordination of interlocked equipment specified in this Section and elsewhere.
5. Review required testing, inspecting, and certifying procedures.

#### 1.6 ACTION SUBMITTALS

##### A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for stationary loading dock equipment.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

##### B. Shop Drawings: For stationary loading dock equipment.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of anchors and each field connection.
3. Include diagrams for power, signal, and control wiring.

#### 1.7 INFORMATIONAL SUBMITTALS

##### A. Qualification Data: For Installer.

##### B. Welding certificates.

##### C. Product Test Reports: For each dock leveler, for tests performed by manufacturer and witnessed by a qualified testing agency.

1. Indicate compliance of dock levelers with requirements in MH 30.1 for determining rated capacity based on comprehensive testing within last two years of current products.
2. Submittal Form: According to MH 30.1.

##### D. Sample Warranty: For manufacturer's special warranty.

#### 1.8 CLOSEOUT SUBMITTALS

##### A. Operation and Maintenance Data: For stationary loading dock equipment to include in operation and maintenance manuals.

#### 1.9 QUALITY ASSURANCE

##### A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

#### 1.10 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of construction contiguous with stationary loading dock equipment, including recessed pit dimensions, slopes of driveways, and heights of loading docks, by field measurements before fabrication.

#### 1.11 WARRANTY

Manufacturer's Special Warranty: Manufacturer agrees to repair or replace dock levelers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
  - a. Structural failures including cracked or broken structural support members, load-bearing welds, and front and rear hinges.
  - b. Faulty operation of operators, control system, or hardware.
  - c. Deck plate failures including cracked plate or permanent deformation in excess of 1/4 inch between deck supports.
  - d. Hydraulic system failures including failure of hydraulic seals and cylinders.
2. Warranty Period for Structural Assembly: 10 years from date of Substantial Completion.
3. Warranty Period for Hydraulic System: Four years from date of Substantial Completion.
4. Warranty shall be for unlimited usage of leveler for the specified rated capacity over the term of the warranty.

## PART 2 - PRODUCTS

### 2.1 RECESSED LOADING DOCK LEVELERS

A. General: Recessed, hinged-lip-type dock levelers designed for permanent installation in concrete pits preformed in the edge of loading platform; of type, function, operation, capacity, size, and construction indicated; and complete with controls, safety devices, and accessories required.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by the Professional:
  - a. Rite-Hite, RMH Series.
  - b. Grainger.
  - c. DLM Dock Leveler Manufacturing.
  - d. McGuire.
  - e. Serco.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.



- C. Standard: Comply with MH 30.1.
- D. Rated Capacity: Capable of supporting total gross load of 30,000 lbs without permanent deflection or distortion.
- E. Platform: Not less than 1/4-inch-thick, nonskid steel plate.
  - 1. Platform Width: As indicated on Drawings.
  - 2. Platform Length: As indicated on Drawings.
  - 3. Frame: Clean-pit type, designed to support leveler at sides of pit, with no supports at front of pit floor.
  - 4. Toe Guards: Equip open sides of dock leveler over range indicated with steel toe guards.
    - a. Toe-Guard Range: Entire upper working range.
- F. Hinged Lip: Not less than 5/8-inch-thick, nonskid steel plate.
  - 1. Hinge: Full-width, piano-type hinge with heavy-wall hinge tube, with gussets on lip and ramp for support.
  - 2. Safety Barrier Lip: Designed to protect material-handling equipment from an accidental fall from loading platform edge of the dock leveler when the leveler is not in use.
- G. Function: Dock levelers shall compensate for differences in height between truck bed and loading platform.
  - 1. Vertical Travel: Operating range above platform level of sufficient height to enable lip to extend and clear truck bed before contact with the following minimum working range:
    - a. Above Adjoining Platform: 12 inches.
    - b. Below Adjoining Platform: 12 inches.
  - 2. Automatic Vertical Compensation: Floating travel of ramp with lip extended and resting on truck bed shall compensate automatically for upward or downward movement of truck bed during loading and unloading.
  - 3. Automatic Lateral Compensation: Tilting of ramp with lip extended and resting on truck bed shall compensate automatically for canted truck beds of up to 4 inches over width of ramp.
  - 4. Lip Operation: Manufacturer's standard mechanism, which automatically extends and supports hinged lip on ramp edge with lip resting on truck bed over dock leveler's working range, allows lip to yield under impact of incoming truck and automatically retracts lip when truck departs.
    - a. Length of Lip Extension: Not less than 12 inches from face of dock bumpers and not less than 16 inches measured from ramp edge.
  - 5. Automatic Ramp Return: Automatic return of unloaded ramp, from raised or lowered positions to stored position, level with platform, as truck departs.
- H. Hydraulic Operating System: Electric control from a remote-control station; fully hydraulic operation. Electric-powered hydraulic raising and hydraulic lowering of ramp. Equip leveler with a packaged unit including a unitized, totally enclosed, nonventilated electric motor, pump, manifold reservoir, and valve assembly of proper size, type, and operation for capacity of leveler indicated. Include means for lowering ramp below platform level with lip retracted behind dock bumpers. Provide a hydraulic velocity fuse connected to main hydraulic cylinder to limit loaded ramp's free fall to not more than 3 inches.

1. Remote-Control Station: Weatherproof single-button station of the constant-pressure type, enclosed in NEMA ICS 6, Type 4 box. Ramp raises by depressing and holding button; ramp lowers at a controlled rate by releasing button.
    - a. Dual-Panel Control Station: Remote-control station for operating side-by-side dock levelers.
  2. Independent Lip Operation: Electric-powered hydraulic raising and hydraulic lowering of lip, controlled independent of raising and lowering of ramp.
- I. Construction: Fabricate dock-leveler frame, platform supports, and lip supports from structural- or formed-steel shapes. Weld platform and hinged lip to supports. Fabricate entire assembly to withstand deformation during both operating and stored phases of service. Chamfer lip edge to minimize obstructing wheels of material-handling vehicles.
1. Cross-Traffic Support: Manufacturer's standard method of supporting ramp at platform level in stored position with lip retracted. Provide a means to release supports to allow ramp to descend below platform level.
  2. Maintenance Strut: Integral strut to positively support ramp in up position during maintenance of dock leveler.
- J. Materials:
1. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
  2. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from steel plate complying with ASTM A572/A572M, Grade 55.
  3. Steel Tubing: ASTM A500/A500M, cold formed.
  4. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- K. Dock-Leveler Finish: Manufacturer's standard prime-paint or baked-on factory finish.
1. Toe Guards: Baked-on factory finish.
- L. Accessories:
1. Curb Angles: 3-by-3-by-1/4-inch galvanized-steel curb angles for edge of recessed leveler pit, with 1/2-inch-diameter by 6-inch- long concrete anchors welded to angle at 6 inches o.c.
  2. Self-Forming Pan: Manufacturer's standard prefabricated, self-forming steel form system for poured-in-place construction of concrete pit.
  3. Side and rear weatherseals.
  4. Foam insulation under dock-leveler platform.
  5. Abrasive skid-resistant surface.

## 2.2 FINISH REQUIREMENTS

- A. Finish loading dock equipment after assembly and testing.
- B. Electrodeposited Zinc Coatings: ASTM B633.
- C. Steel Prime Paint Finish: Clean, pretreat, and apply manufacturer's standard primer.

- D. Baked-on Factory Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
  - 1. Color: Manufacturer's standard.
  - 2. Toe Guards: Paint to comply with ANSI Z535.1.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical systems for loading dock equipment to verify actual locations of connections before equipment installation.
- C. Examine walls and floors of pits for suitable conditions where recessed loading dock equipment is to be installed. Pits shall be plumb and square and properly sloped for drainage from back to front of loading dock.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 PREPARATION**

- A. Set curb angles in concrete edges of dock-leveler recessed pits with tops flush with loading platform. Fit exposed connections together to form hairline joints.
- B. Set curb angles in concrete edges of truck-leveler recessed pits with tops flush with driveway. Fit exposed connections together to form hairline joints.
- C. Place self-forming pan system for recessed dock levelers in proper relation to loading platform before pouring concrete.
- D. Clean recessed pits of debris.

#### **3.3 INSTALLATION, GENERAL**

- A. Install loading dock equipment as required for a complete installation.
  - 1. Rough-in electrical connections.

#### **3.4 INSTALLATION OF RECESSED LOADING DOCK LEVELERS**

- A. Attach dock levelers securely to loading dock platform, flush with adjacent loading dock surfaces and square to recessed pit.

3.5 ADJUSTING

- A. Adjust loading dock equipment to function smoothly and safely, and lubricate as recommended by manufacturer.
- B. Test dock levelers for vertical travel and adjust to maintain operating range indicated.
- C. After completing installation of exposed, factory-finished loading dock equipment, inspect exposed finishes and repair damaged finishes.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain loading dock equipment.

**END OF SECTION 111319**

**SECTION 114000  
FOOD SERVICE EQUIPMENT**

**PART 1 – GENERAL SPECIFICATIONS**

1.00 SCOPE OF WORK AND RELATED WORK:

A. Scope of Work: The Kitchen Equipment Contractor is to furnish all labor, materials, equipment, and services necessary to furnish and deliver all Food Service Equipment specified in Section 114000 into the building or buildings, uncrate, assemble, hang, set in place, level, and completely install unless otherwise noted, exclusive of final utility connections which are by Divisions 22, 23 and 26. The K.E.C. shall provide start-up and testing of all equipment furnished by K.E.C. (See Section 3.2 - START UP AND TESTING)

B. Related work to be furnished by Other Trades:

1. All plumbing, electrical, mechanical and ventilation work required along with the food service equipment including roughing in of utilities required as indicated on the Food Service Consultant Design Drawings and the Contract documents along with the final connections from the rough ins to the equipment, utility service to rough ins and all utility connections shall be by Divisions 22 and 26.
2. All fittings, hoses, valves, check valves, stops, traps, direct and indirect wastes with tailpieces, strainers, etc. required for equipment in this section will be furnished and installed by Division 22 unless specifically called for otherwise under any item.
3. All fittings, wire, disconnect switches, safety switches, convenience boxes, outlets, materials and connections will be furnished and installed by Division 26 unless specifically called for otherwise.
4. All interconnections between the building components and equipment along with materials needed for such will be by Divisions 22 and 26 unless specifically called for otherwise under any item. The Kitchen Equipment Contractor shall furnish any technical support required for these interconnections from the factories, etc.
5. Any starters, valves, faucets, tailpieces, etc. furnished loose with the equipment will be installed by Divisions 22 and 26.
6. Any sleeves or conduit required for soda lines, cash registers, refrigeration, beer lines and carbonation lines will be furnished and installed by Division 26.
7. Any electrical and plumbing interconnections to and between compressors, blower coils, controls, lights, etc. along with final connections will be furnished and installed by Divisions 22 and 26 unless stated otherwise.
8. Any ventilating fans and all duct work required for a complete operation system as well as any access panels required for fire protection nozzles in the ductwork will be furnished by Division 23 unless specifically noted otherwise. If the Exhaust & MUA Fans are furnished by the K.E.C., they will be furnished loose along with the roof curbs to the General Contractor for installation by the General Contractor.  
NOTE: General Contractor and/or HVAC Contractor shall provide proper air handling balancing by an Authorized Balancing Company between the Exhaust/MUA Fans and Room Air System to ensure negative balance at the Exhaust Hood. Coordinate with K.E.C.
9. All penetrations/sleeves, in walls, floors or ceilings including roof pitch pockets needed for equipment as well as any access panels for any food service equipment not furnished by the food service equipment vendor will be furnished by the General Contractor unless specifically noted otherwise.

1.01 DEFINITIONS:

A. All references to the terms "Kitchen Equipment Contractor" or "K.E.C." in

these specifications and/or on the drawings shall be defined as meaning the Kitchen Equipment Contractor/Supplier.

B. All references to the term "Owner" in these specifications and/or drawings shall be defined as meaning the Owner or Owner's representative.

- C. All references to the term "Consultant" or "Food Service Equipment Consultant" in these specifications and/or drawings shall be defined as meaning DRAFTING & DESIGN, LLC and its authorized representatives.

#### 1.02 QUALIFICATIONS:

A. Qualification of Supplier:

1. Commercial Food Service Equipment Suppliers shall comply with the following qualifications.
  - a. List of projects successfully completed of comparable scope if requested.
  - b. Must have manufacturer's authorization to distribute and install specified equipment.
  - c. Provide an experienced staff of foodservice equipment installers.
  - d. Prepare/provide professional roughing in drawings and brochure books if required.
  - e. Must have access to fabrication companies meeting N.S.F. requirements that is familiar with and regularly produce Food Service Equipment.
  - f. Must have access to a stock of repair and replacement parts along with factory authorized service companies.

B. Qualification of Fabricators:

1. Any fabricator to be used shall be a N.S.F. approved company and must have trained personnel and facilities to comply with these specifications and any details attached.
2. All custom fabricated equipment shall bear the N.S.F. (National Sanitation Foundation) seal of approval.
3. One fabricator must be used per project and all equipment must be fabricated at the same shop.

C. Qualifications of Manufacturers:

1. All manufacturers shall be routinely engaged in the production of items to be furnished and have demonstrated the capability to regularly furnish similar equipment that performs the functions specified within. All equipment to be the latest in design that complies with these specifications.

D. Discrepancies:

1. Any discrepancies with contract documents should be brought to the attention of the Consultant in writing for clarification prior to ordering or fabricating of any items.

#### 1.03 PLANS AND SPECIFICATIONS:

- A. These documents (plans & specifications) have been prepared for the use in procuring, installation, erection and start up of all the equipment in these specifications and contract. These plans and specifications are to be considered as mutually explanatory and work required by one, but not the other, will be performed as though required by both. When there is any discrepancy between drawings and specifications, drawings will govern. Any discrepancies are to be clarified from the Consultant before bidding.

#### 1.04 SUBMITTAL REQUIREMENTS:

- A. The submittals for this project are to be submitted within four (4) weeks or within the time frame described by the General Contractor or Owner

- to meet the project's time frame. Assemble and submit all shop drawings, rough in drawings, brochures, color samples/charts, etc. in order to submit a complete package. No reviews of incomplete submittals will be performed.
- B. Should there are any delays to this project due to non-submittal of the complete package by the K.E.C., the K.E.C. will be responsible for all costs associated with this delay.
  - C. Mark each submittal with the Project Name, date, contractor and any other information needed to properly identify the submittals.
1. **PLAN & ROUGH-IN DRAWINGS:**
    - a. Submit an electronic set of drawings for the food service equipment professionally prepared from the architectural dimensioned plans at a minimum scale of 1/4" = 1' - 0". Consultants Dimensioned Design Rough-in drawings may be used only with permission. The K.E.C. shall double check all utility information to verify accuracies. It is the responsibility of the K.E.C. to verify all quantities, utilities, etc.
    - b. Submit an Equipment Layout Plan with arrangement of all specified items identified on a schedule listing item number, description, quantity, manufacturer, model number.
    - c. Submit Plumbing and Electrical drawings showing dimensioned locations, sizes, elevations, and capacities of all utility services required for each item of equipment in relation to finished walls, columns, and heights above finished floor.
    - d. Submit a special condition plan showing exact dimensions and details of all masonry bases, floor depressions, critical partition locations and heights, wall openings, reinforcing for wall and/or ceiling mounted equipment, and conduit locations for soda, beer, and refrigeration lines. In addition, on this plan, show ventilation dimensioned locations for all duct openings for ventilators and dish machines identifying size, C.F.M.'s required for exhaust and supply, static pressures, and connection heights.
  2. **EQUIPMENT BROCHURES:**
    - a. Submit an electronic copy of manufacturer's brochures along with information sheets indicating item numbers, quantities, model numbers, all utility information and accessories per the specifications. Include any deviations from standard information. These brochure books must be approved before procurement. Include any manufacturer's schematic drawings for mechanical and electrical services for any equipment that may require technical support.
  3. **SHOP DRAWINGS:**
    - a. For manufactured equipment that requires shop drawings for approvals, such as walk in cooler/freezers, ventilator, and utility distribution systems, refrigeration systems and custom fabrication, submit an electronic set for review and approvals.
  4. **OPERATIONAL AND MAINTENANCE MANUALS:**
    1. Submit four (4) hardbound sets for all standard equipment that is mechanically operated.
    2. Include operating, maintenance and cleaning instructions, parts listing recommended parts inventory listing and purchase source, copies of all warranties, schematics, etc. from manufacturer.
    3. Manuals shall be marked with the project name, project number, name of contractor, date, and any other appropriate information. There should

be information sheets in front of each item of maintenance manuals marked with the item numbers for proper identification.

4. Include in the front of each manual, include a list of all manufacturers representatives of the food service equipment and the factory authorized service agency for each piece of equipment along with addresses, Telephone numbers and contacts.
  5. SAMPLES:
    1. If requested, samples of materials, products, and fabrication methods, shall be submitted for approvals at no extra cost, before proceeding with the work.
  6. RESUBMISSION PROCEDURES:
    - a. Drawings: Revise all drawings as noted, indicate all revisions on the drawings including any requested by the Consultant. Resubmit under conditions as previously outlined above.
    - b. Product Data: Resubmit new brochures, etc. as noted. Indicate any revisions on the data. Resubmit under conditions as previously outlined above.
    - c. Make all re-submittals with two working weeks, ten (10) days from date K.E.C. received marked up submittals.
  7. APPROVALS OF SUBMITTALS:
    - a. After K.E.C. has received approved packages, furnish as many prints and /or copies as requested for various trades, the Owner, the Architect and the Consultant.
    - b. The approval of drawings are general and in no way relieves the K.E.C. of the responsibility of proper fitting, finishes, quantities, and erection of the work in strict accordance with the contract requirements, nor does it relieve the K.E.C. of the responsibility of furnishing materials and workmanship not indicated on approved drawings but required for the completion of the work.
    - c. Approvals by the Consultant and/or Owner of the submittals by the K.E.C. does not waive the responsibility of the K.E.C. to furnish each item of equipment in complete accordance with the specifications and drawings including accessories, finishes, etc. Discrepancies between Contract Documents and furnished equipment shall be corrected even after approvals and installation of said equipment at no additional cost to the Owner.
- 1.05 PRODUCT STORAGE, DELIVERY AND HANDLING:
- A. Storage:

All equipment to be stored in a protected area free from weather and job hazards.
  - B. Delivery:

All equipment to be delivered to the job site only after the building is weather proof and vandal safe. Equipment that is installed prior to interior finishes being completed, i.e., ventilators, walk in cooler & freezers should be protected to avoid any damaging of finishes, etc.
  - C. Handling:

All equipment to have the factory wrapping, crating and protective coatings remain on them until installation at the job site. Even at this time, all protective coatings, such as coatings on griddles, fryers, etc. are to remain until the final cleaning to ensure against rust and



contamination.

D. Damages:

K.E.C. has all responsibility for any damages or loss incurred prior to final acceptance by the Consultant/Owner. Any items that may be damaged or lost shall immediately be replaced or repaired to new status to the complete satisfaction by the Owner and at no additional cost to the Owner.

1.06 JURISDICTION TRADE AGREEMENTS AND RESTRICTIONS:

A. Include the work specified, shown or reasonably inferable as part of food service equipment. Portions of this work may be subcontracted to those qualified to do such work, as may be necessary because of jurisdictional trade agreements and restrictions.

1.07 REGULATIONS AND CODES:

A. Except as otherwise indicated, each item of equipment shall comply with the latest current edition of the following standards as applicable to the manufacture, fabrication, and installation of the work in this section.

1. N.S.F. Standards: Comply with National Sanitation Foundation Standards and criteria and provide N.S.F. "Seal of Approval" on each manufactured item and custom fabricated work.
2. UL Standards: For electrical components and assemblies, provide either UL labeled products or, where no labeling service is available provide a complete index of the components used as selected from the UL "Recognized Component Index".
3. A.N.S.I Standards: gas burning equipment must comply with ANSI Z21-Series Standards. Comply with ANSI B57.1 for compressed gas cylinder connections and with applicable standards of the Compressed Gas Association for water connection air gaps and vacuum breakers.
4. A.G.A.: All gas fired equipment shall be A.G.A. approved, equipped to operate on the type gas available at the job site and shall contain 100% automatic safety shut-off devices.
5. N.F.P.A. Standards: Comply with N.F.P.A. Bulletin 96 for Exhaust systems and with N.F.P.A. Bulletins 17 and 96 for fire extinguishing systems.
6. A.S.M.E.: Comply with A.S.M.E. boiler code requirements for steam generating and steam heated equipment. Provide A.S.M.E. inspection, stamps, and certification of registration with National Board.
7. National electric Code: Comply with NEC Volume 5 for electrical wiring and devices included with food service equipment.
8. All authorities having jurisdiction over this type of equipment and/or installation.
9. Where specifications and/or drawings require mechanical, electrical or refrigeration work to be performed, such work shall be done in strict conformance to other portions of the Base Building Specifications which sets forth standards for this type of work.
10. Where there exists two standards or codes for one type of work, the stricter method shall govern.

1.08 WARRANTIES:

A. Provide in writing a warranty for all equipment and fabrication against defects and workmanship for a period of one (1) year from date of acceptance including parts and labor.

B. Refrigeration system compressors shall be warranted for five (5) years

by the manufacturer. Free Refrigeration service, including parts and labor shall be furnished for one (1) year from date of acceptance.

1.09 JOB SITE CONDITIONS:

- A. K.E.C. shall visit the job site to field check actual wall dimensions and roughing ins and shall be responsible for fabricating and installing the equipment in accordance with the available space and utility services as they exist on the job site.
- B. K.E.C. shall verify all door openings, passageways, elevators, etc. to ensure that all equipment can be moved to its proper location within the building and if necessary, check the possibility of holding wall erection, placement of doorjamb, windows, etc. with the General Contractor for the purpose of moving the equipment into its proper location.  
Any removal and/or rebuilding of any of the building in order to properly place the equipment, or if caused by incorrect information of the K.E.C.'s drawings, shall be done at the expense of the K.E.C. at no additional cost to the Owner.
- C. K.E.C. to notify the Consultant and Owner prior to fabrication of equipment of any discrepancies between plans and specification and actual job site conditions.
- D. K.E.C. to physically check the location of all utility rough ins at the job site before the finished walls, floors, etc. are in place. Report any discrepancies in writing to the Consultant and Owner.
- E. Changes required after fabrication has started to ensure equipment accurately fitting the space as it exists and conforming to actual field dimensions on the job shall be made at no additional costs to the owner.
- F. If special hoisting equipment and/or operators/riggers are required for installation, the cost for this should be included as part of the bid for this work.

1.10 CHANGES IN THE WORK:

- A. The owner reserves the right to require reasonable modifications to be made in the routing of work and relocation of equipment. This specifically refers to conditions where interference occurs or where more desirable accessibility can be obtained or whose materials cannot be installed because of structural or mechanical conditions encountered. Such changes shall be made at no additional cost to the Owner.

1.11 PATENTS:

- A. Hold harmless and save the Owner and its officers, consultants, and employees from liability of any nature or kind, including costs and expenses for or on account of any copyrighted, patented, or non-patented invention, process, trademark, design, device, material, article, or appliance manufactured or used in the performance of the contract, including its use by the Owner, unless otherwise specifically stipulated in the Contract Documents.
- B. If the Contractor has information that the process or article specified is an infringement of a patent, they are responsible for such loss unless he promptly notifies the Owner in writing. The contract price shall include all royalties or costs associated from the use of any and all of the above which are, in any way, involved in the contract.

1.12 CONTRACTOR'S WARRANTY:

- A. The K.E.C. represents and warrants that they are financially solvent and that they are experienced and competent to perform the types of work or to

furnish the plans, materials, supplies and/or equipment, to be so performed or furnished by them.

- B. K.E.C. must be familiar with all Federal, State, municipal and department law, ordinances, orders, and regulations, which may, in any way, affect the work of those employed therein. K.E.C. is responsible for any cost for any any permits required to perform their work.
- C. K.E.C. is responsible for reviewing all Contract Documents, specifications, addenda, if any and the job site to ensure that all conditions, etc. are satisfactory to ensure the quality, quantity and installation of all equipment.

1.13 SUBSTITUTIONS:

- A. N/A.
- B. N/A
- C. N/A
- D. N/A
- E. N/A.
- F. N/A
- G. N/A

1.14 DESIGN/MODEL CHANGE - DISCONTINUED ITEMS:

- A. All equipment specified and provided shall be of latest design.
- B. K.E.C. is to notify Consultant in writing of any discontinued items and suggest or request an alternate of equal performance, including all accessories, at no additional costs to the Owner.

PRODUCTS

2.00 GENERAL:

- A. All equipment and internal component parts shall be new and unused. All items of standard manufactured equipment shall be current models at the time of delivery. All parts subject to wear, breakage, or distortion shall be accessible for adjustment, replacement, and repair.
- B. All oil holes, grease fittings, and filler caps shall be accessible without the use of tools and means shall be provided to ensure adequate lubrication for all moving parts.
- C. All equipment shall be designed to provide safe and convenient operation with any covers or other safety devices provided for any items of equipment presenting safety hazards. These safety features shall not present any substantial interference to the operation of the equipment and shall allow easy access to the guarded parts.
- D. When trim is required in lieu of rejection of items of equipment, it shall be the K.E.C.'s responsibility to provide same at no additional costs. Trim is not to be a substitute for accuracy.

2.1 FABRICATION OF METAL WORK:

- A. Metal and Gauges: Except as otherwise indicated, fabricate exposed metalwork of stainless steel; and fabricate the following components from gauge of metal indicated, and fabricate other components from not less than 20 gauge metal:
  - 1. Table Tops & Counter Tops: 14 gauge S/S, Type 302, No. 4 finish.
  - 2. Shelves: 16 gauge S/S (18 gauge if less than 12" wide)
  - 3. Front Drawer/Door Panels: 18 gauge S/S (double pan type)
  - 4. Single Pan Doors and Drawer Fronts: 16 gauge S/S
  - 5. Enclosed Base Cabinets & Wall Cabinets: 18 gauge S/S
  - 6. Sinks, Drain boards and Compartment Covers: 14 gauge S/S
  - 7. Exhaust Hoods: as specified
  - 8. Pan Type Insets and Trays: 16 gauge S/S
  - 9. Removable Covers/Panels, Skirts and Enclosure Panels: 18 gauge S/S
  - 10. Closure and Trim Strips over 4" wide: 18 gauge S/S
  - 11. Hardware Reinforcements: 12 gauge

- 12. Gusset Plate: 10 gauge
- 13. Legs – 1-5/8" dia. S/S tubing, Type 304, No. 4 finish
- 14. Cross bracing – 1-1/2" dia. S/S tubing, Type 304, No. 4 finish.
- B. Work Surface Fabrication: Fabricate metal work surfaces by forming and welding to provide seamless construction, using welding rods matching sheet metal, grinding and polishing. Where necessary for disassembly, provide with waterproof gasket, draw type joints with concealed bolting.
- C. Reinforce work surfaces 30" O.C. both ways with galvanized or stainless concealed structural members. Reinforce edges which are not self-reinforced by forming.
- D. Sound deaden the underside of metal work surfaces, including sinks and similar units, with a coating of sound deadening material. Hold coating back 3" from sanitary edges for cleaning.
- E. Structural Framing: Except as otherwise indicated, provide framing of minimum 1" pipe size, round pipe or tube members with mitered and welded joints and gusset plates, ground smooth and polished. Provide 14-gauge, stainless steel tube for exposed framing and galvanized steel pipe for concealed framing in areas exposed to customer's view; in non-customer's views, provide either stainless steel tube or enamel finished steel pipe for exposed framing, and either galvanized or enamel finished steel pipe for concealed framing (where permitted by NSF standards, and at fabricator's option).
- F. Casework: At fabricator's option, and unless otherwise indicated, provide either box-type face framing or open channel type (complying with NSF requirements in either case).
- G. Enclosure: Except as otherwise indicated, provide each unit of casework, (base, wall, overhead and free standing) with a complete enclosure metal cabinet, including fronts, backs, tops, bottoms and sides.
- H. Door and Drawer Fronts: Except as single pan construction is indicated, provide double pan type, not less than 5/8" thick, with seams on inside face. Weld hardware reinforcements inside of inner pan. Sound deadened by either coating both pans on concealed face, or by inserting mineral wool insulation between the pans.
- I. Shelves: Except as otherwise indicated, provide adjustable standards for positioning and supporting of shelves in casework. Turn back edge of shelf units up 2" and hem. Turn other edges down to form an open channel. Reinforce shelf units to support 40 lbs. per square foot loading, plus 100% impact loading.
- J. Drawer bodies: Except as otherwise indicated, draw form drawer bodies from a single piece of metal to provide seamless construction. Flange top edge to protect slides from spillage.
- K. Closed Base: Where casework is indicated to be located on a raised floor base, prepare casework for support without legs, and for anchorage and sealant application, as required for a completely enclosed and concealed base.
- L. Support from floor: Equip floor supported, mobile units with casters and equip items indicated as "roll-in" or "roll-out" units with the manufacturer's standard, single directional rollers. Otherwise, and except for closed base units, provide pipe or tube legs with adjustable, stainless steel bullet feet for floor supported items of fabricated metal work. Provide a 2" adjustment of feet with concealed threads.

## 2.2 EXHAUST HOODS:

- A. Comply with NFPA No. 96 and all applicable appendixes.
- B. Installation: Install in a secure and sanitary manner.
- C. Grease Removal: Provide type indicated (removable filters if not otherwise specified) with drip channel gutters, drains and removable, stainless steel collection basins.
- D. Light Fixtures: Provide fluorescent fixtures (or otherwise as specified) outside the hood with sealed safety lenses flush with the inside of the hood with stainless steel exposed conduit for wiring.
- E. Fire Extinguishing System(s): Provide as specified. System shall comply with NFPA No. 12 including all appendixes. Furnish completely with automatic gas and/or electrical shut-offs and support accessories as required for complete safety against fire. Comply fully with all applicable standards of applicable agencies and associations.

### 2.3 PLASTIC LAMINATE CASEWORK:

- A. General: Fabricate plastic laminate casework in the types and styles indicated, with hardware and accessories. Provide exposed and semi-exposed surfaces and edges (self-edged) with plastic laminate covering on particle board, plywood or metal as specified. Plastic laminate shall be as specified by the Architect and/or the Owner as indicated. Paint plywood or hardboard for all concealed panels or as otherwise indicated.
- B. Provide adjustable standards for positioning and support of shelves.
- C. Comply with applicable standards of the Architectural Woodwork Institute for not less than (Custom Grade) casework. Additionally, comply with the Woodwork Institute of California for "Custom Grade" casework.

### 2.4 REFRIGERATION EQUIPMENT:

- A. General: Provide either single or multiple compressor units, as recommended by the manufacturer for size and variations between connected evaporator loads as indicated. Provide units of capacities indicated; arrange to respond to multiple evaporator thermostats and defrosting timers. Indicate coils, receivers, compressors, motors, motor starters, mounting bases or stands, housings, vibration isolation units, fans, dryers, valves, piping, insulation, gauges, winter controls equipment and completely automatic control system.
- B. Refrigerants: Pre-charge units with type or types recommended by the manufacturer for services indicated, with quick-disconnect type of connections ready to receive refrigerant piping runs to evaporators and, where remote, to condensers unless specified otherwise.
- C. Condensers: Provide air, water and/or combination air/water cooled condensers as specified, ready for piping connections with condenser water piping and drain or return. Locate units with compressors complete with refrigerant piping installed at the factory. Maximum incoming water temperature is 75 degrees F to 0 degrees condensers, located with the compressors, complete with refrigerant piping installed at the factory. Locate units as shown – if exterior, with weather housings and protective enclosures. The minimum outdoor operating ambient temperature for design of units is -10 degrees F to 0 degrees F. Maximum ambient condition for load on the air cooled condenser is 95 degrees F with 75% relative humidity in basically still air.

## EXECUTION

### 3.0 INSPECTION AND PREPARATION:

- A. Rough-In Work: The K.E.C. must examine roughed-in mechanical and electrical service, installation of floors, walls, columns and ceilings and conditions under which the work is to be installed, and must verify dimensions of services and substrates before fabricating the work. Notify the Contractor in writing of unsatisfactory conditions for proper installation of food service equipment. Do not proceed with fabrication and installation until unsatisfactory dimensions and conditions are corrected in a manner acceptable to the K.E.C. The K.E.C. must field verify all measurements at the building prior to fabrication of custom equipment.

### 3.1 INSTALLATION:

- A. The K.E.C. shall coordinate delivery schedule with the General Contractor to ensure adequate openings in the building for access for equipment.
- B. Equipment shall be uncrated, fully assembled and set level in position for final connections. Parts shipped loose but required for connections be properly tagged and shall be accompanied by the necessary instructions.
- C. Provide a competent, experienced installer to supervise installation and coordinate final connections with the other trades.
- D. The General Contractor is responsible for installation of wall backing at all locations of any wall mounted/fastened equipment. The K.E.C. is to coordinate with General Contractor regarding the heights, etc.

- 3.2 START UP AND TESTING:
- A. Delay startup of food service equipment until service lines have been tested, balanced, and adjusted for pressure, voltage, and similar considerations; and until water and steam lines have been cleaned and treated for sanitation.
  - B. Before testing, lubricate each equipment item in accordance with manufacturer's recommendations.
  - C. Supply a trained person(s) to start up all equipment, test and make adjustments as necessary, resulting in all equipment, including controls and safety devices, performing in accordance with manufacturer's specifications.
  - D. Repair or replace any equipment found defective in its operation, including equipment which are below capacity or operating with excessive noise or vibration unless equipment was damaged by others. Proof of this damage is required by K.E.C.
- 3.3 DEMONSTRATION:
- A. Instruct the Owners operating personnel in the proper operation and maintenance procedures for each item of operational food service equipment that has daily usage of controls. Equipment that does not have any controls, i.e., worktables, sinks, etc. does not require demonstrations except for instructions on proper cleaning. The fire suppression system is demonstrated to the Owner at the time of testing for the Fire Marshal or proper authority. Instructions as to what to do in case of a fire are required for the Operating personnel. The Owner shall dictate which equipment is to be demonstrated.
  - B. Such instructions shall be provided at the convenience of the Owner and the operating staff; however, no instructions shall be considered valid unless the equipment is completely operational for the purpose of demonstrating or instructing.
  - C. Assemble, tag and label all keys from equipment and turn over to the Owner for their use.
- 3.4 WARRANTY SERVICE:
- A. Properly explain the procedures for reporting service calls in case of malfunctioning equipment; person(s) to call, information required before calling in a service problem, etc.
- 3.5 CLEANING AND ADJUSTMENTS:
- A. Upon completion of the installation and testing, clean and sanitize all food service equipment, and leave in a condition ready for use by the operating staff.
  - B. Remove all protective coverings, and thoroughly clean equipment both internally and externally.
  - C. Make any final adjustments required for proper operation of the equipment.
  - D. Remove any abrasions, dents, and other damages and restore any finishes marred during installation. Polish stainless-steel surfaces and touch up any painted surfaces with original paint to match.
  - E. Remove all refuse, rubbish, scrap materials, and debris caused by the work of this Section, and leave the site in a neat, orderly, and broom clean condition.
- 3.6 CODE CONFORMANCE:
- A. All equipment and installations shall conform to all applicable codes, including but not limited to, the County, State and local authorities, including Health Department. All equipment indicated in the drawings are subject to final approval by code authorities and shall be required to conform to codes at no change in price. It is the responsibility of the K.E.C. to conform to all code requirements.

**End of Part 1 – Section 114000**

**SECTION 114000  
FOOD SERVICE EQUIPMENT**

**PART 2 – ITEMIZED SPECIFICATIONS**

**Scope of Work:** The Kitchen Equipment Contractor (K.E.C.) is to furnish all labor, materials, equipment and services necessary to furnish and deliver all Food Service Equipment specified in Section 114000 into the building or buildings, uncrate, assemble, hang, set in place, level, and completely install unless otherwise noted, exclusive of final utility connections which are by Divisions 22 and 26 as outlined in Part 1. The K.E.C. shall provide start-up and testing of all equipment furnished by K.E.C. along with demonstrations of equipment to the Owner. If the Exhaust & MUA Fans are furnished by the K.E.C., they will be furnished loose along with the roof curbs to the General Contractor for installation by the General Contractor. All cranes, operators, riggings, etc. to be furnished by the General Contractor as required. K.E.C. shall visit the job site to field check actual wall dimensions and rough-ins and shall be responsible for fabricating and installing the equipment in accordance with the available space and utility services as they exist on the job site. K.E.C. shall verify all door openings, passageways, elevators, etc. to ensure that all equipment can be moved to its proper location within the building and if necessary, check the possibility of holding wall erection, placement of doorjamb, windows, etc. with the General Contractor for the purpose of moving the equipment into its proper location.

**Related work to be furnished by Other Trades:** All plumbing, electrical, mechanical and ventilation work including ductwork connections, penetrations to walls, floors or ceilings required for the food service equipment including roughing in of utilities required as indicated on the Food Service Consultant Design Drawings and the Contract documents along with the final connections from the rough ins to the equipment, utility service to rough ins and all utility connections shall be by Divisions 22 and 26. All interconnections between the building components and equipment along with materials needed for such will be by Divisions 22 and 26 unless specifically called for otherwise under any item. The Kitchen Equipment Contractor shall furnish any technical support required for these interconnections from the factories, etc.

**K.E.C. INSTALLATION NOTES:**

1. All Storage Floor Shelving Units shall be assembled by the Kitchen Equipment Contractor with the bottom shelf at 10 inches above finished floor and the remainder spaced equally unless stated otherwise.
2. All Wall Shelves shall be installed with BOTTOM shelf work surface at 60 inches above finished floor with TOP shelf (if applicable) at 14 inches above work surface of BOTTOM shelf unless otherwise noted.
3. All Wall Shelves with Utensil Rails shall be installed with shelf work surface at 66 inches above finished floor.
4. All Wall Mounted Pot Racks shall be installed with BOTTOM rail at 60 inches above finished floor unless otherwise noted.
5. All Wall Mounted Dish Sorting Shelves shall be installed with BOTTOM EDGE of shelf at 60 inches above finished floor unless otherwise noted.

**(NIKEC – NOT IN KITCHEN EQUIPMENT CONTRACT – FURNISHED/INSTALLED BY OTHERS)**

**(BY OWNER – NOT IN KITCHEN EQUIPMENT CONTRACT – FURNISHED/INSTALLED BY OWNER)**

ITEM # 1	WALK-IN COOLER/FREEZER ASSEMBLY
Quantity:	One (1)
Manufacturer:	Custom
Model:	BALLY or equal as approved by the Professional

One (1) Model BALLY Quote No: 220433-1-0-HND Indoor Structure  
SEE SHEET QK-400 FOR DESIGN INTENT SHOP DRAWINGS  
Bally Prefabricated Exterior Dimensions: 25'-5¾" Length x 21'-2" Width x 8'-6" Height 3  
Compartments. With Floor in Pit Ceiling: Multi Span -Self-Supporting.  
Panel Thickness: 4" Exterior Vertical Used (7'-10") with 4" Partition, 4" Floor, 4" Ceiling.

Details and specifications for Quote No: 220433-1-0-HND Comments: Quoting Bally standard sizes. Floor to be covered with epoxy once box is installed.

Base Finish: Vertical and Ceiling Panels: Embossed Galvalume (26 GA) Base Finish Interior Floor: Galvanized (16 GA).

Special Finishes: Interior Verticals - Embossed White (190 Series) Interior Ceiling - Embossed White (190 Series) Exposed Ext. Verticals - Stucco Aluminum.

Doors/Openings: 3 36" x 78" Hinged Door In a 46" x 94" Panel.

Doors accessories:

3 Mod 75LC Multi-Monitor Alarm (Options below)

3 Mod 75LC Multi-Monitor(Opt)IP1 Push Button(Add) 3 Mod 75LC Multi-Monitor(Opt)MC1F Mag.Contact(Add)

3 Super Door 36" Wide and Under, 48" High 1/8" D.T. Kickplate Int. & Ext.

3 Door Window (14 x 14) Norfab - 4" Door

3 Strip Curtain (36" Door and Under)

Accessories and Extras:

35 L/F Vinyl Rub Rail (Grey Color)

21 L/F Self Supporting Std. Angle (4")

7 48" LED KEIL 48x754-CL-N Light - 40° F to 100° F(Range)

2 Bally Standard Pressure Relief Port (< 400 sq/ft)

536 S/F 1/2" Plywood Foamed in Panel

138 S/F 1/8" Aluminum Diamond Tread (Wainscot) - 48" High Exposed Exterior.

56 S/F Emboss Galvalume (Closure Metal)

A. Extra lights to be shipped loose for field installation by K.E.C. with wiring by Electrical Contractor.

B. Provide matching trim strips from the sides and tops of assembly to building walls. K.E.C. to verify all dimensions.

C. All electrical conduits to be run above walk in ceiling panels by Electrical Contractor.

D. Evaporator coil drain lines shall be run to floor drain with "P" trap on exterior of assembly by Plumbing Contractor in accordance with all codes and regulations.

E. Black "Armaflex" insulation to be applied to all exposed drain lines and fittings inside of assemblies by K.E.C. Refrigeration Contractor (after heat tape is applied on freezer drain lines).

F. Spiral heat tape to be furnished and installed (for continuous 24 hour operation) on evaporator coil drain line inside of freezer compartment prior to installation of insulation by Electrical Contractor. (And on any exterior drain lines outside of building if applicable)

G. All openings and conduits are to be sealed to prevent infiltration of warm, humid air into compartments.

H. Provide manufacturers shop drawings for review and approval.

ITEM # 2 EVAPORATOR COIL FOR COOLER

Quantity: One (1)

Manufacturer: Custom

Model: BALLY or equal as approved by the Professional

One (1) Model BALLY Quote No: 220433-1-0-HND

BLP211MA-S1D-SV+ 115/1/60

SmartVap+ Air Defrost with EEV Installed

1. Refrigeration Systems shall be pre-assembled remote with condensing units supplied with all "in-Line" parts and controls including refrigeration lines, sight glass, drier, vibration eliminator, time clock (for all low temperature units).

2. All Outdoor Remote Condensers shall be supplied with base and weather cover and low ambient protection which shall consist of crankcase heaters, thermostat with solenoid valve (pump down) and head pressure control as low ambient protection for outdoor protection.

3. A qualified technician shall be required on site to accomplish installation, check-out and start-



up procedures.

4. The KEC shall furnish & install the evaporator coils in the walk-in cooler/freezers.
5. The KEC shall furnish & install refrigeration lines.
6. The KEC shall be responsible installing/lifting, etc. the condensers to the roof or on grade as stated or if an indoor installation, install where shown on plans.
7. The General Contractor shall provide all roof curbs, pitch pockets, concrete pads, and sleeved openings in walls, floors and ceilings as required providing unobstructed access from the Walk-In Cooler/Freezer Assemblies to the Remote Condensing Units at their final locations. Coordinate with the General Contractor.

ITEM # 3                      REMOTE CONDENSER UNIT FOR COOLER, OUTDOORS

Quantity:                      One (1)  
Manufacturer:                  Custom  
Model:                          BALLY or equal as approved by the Professional

One (1) Model BALLY Quote No: 220433-1-0-HND  
BEZA 010 H8 HS2DB (208-230/1/60) w/ smart speed  
Scroll Unit 12000 BTU

1. Refrigeration Systems shall be pre-assembled remote with condensing units supplied with all "in-Line" parts and controls including refrigeration lines, sight glass, drier, vibration eliminator, time clock (for all low temperature units).
2. All Outdoor Remote Condensers shall be supplied with base and weather cover and low ambient protection which shall consist of crankcase heaters, thermostat with solenoid valve (pump down) and head pressure control as low ambient protection for outdoor protection.
3. A qualified technician shall be required on site to accomplish installation, check-out and start-up procedures.
4. The KEC shall furnish & install the evaporator coils in the walk-in cooler/freezers.
5. The KEC shall furnish & install refrigeration lines.
6. The KEC shall be responsible installing/lifting, etc. the condensers to the roof or on grade as stated or if an indoor installation, install where shown on plans.
7. The General Contractor shall provide all roof curbs, pitch pockets, concrete pads, and sleeved openings in walls, floors and ceilings as required providing unobstructed access from the Walk-In Cooler/Freezer Assemblies to the Remote Condensing Units at their final locations. Coordinate with the General Contractor.

ITEM # 4                      EVAPORATOR COILS FOR FREEZER

Quantity:                      Two (2)  
Manufacturer:                  Custom  
Model:                          BALLY or equal as approved by the Professional

Two (2) Model BALLY Quote No: 220433-1-0-HND  
BLP211LE-S2D SV+ 208-230/1/60  
SmartVap+ Electric Defrost with EEV Installed

1. Refrigeration Systems shall be pre-assembled remote with condensing units supplied with all "in-Line" parts and controls including refrigeration lines, sight glass, drier, vibration eliminator, time clock (for all low temperature units).
2. All Outdoor Remote Condensers shall be supplied with base and weather cover and low ambient protection which shall consist of crankcase heaters, thermostat with solenoid valve (pump down) and head pressure control as low ambient protection for outdoor protection.
3. A qualified technician shall be required on site to accomplish installation, check-out and start-up procedures.
4. The KEC shall furnish & install the evaporator coils in the walk-in cooler/freezers.

5. The KEC shall furnish & install refrigeration lines.
6. The KEC shall be responsible installing/lifting, etc. the condensers to the roof or on grade as stated or if an indoor installation, install where shown on plans.
7. The General Contractor shall provide all roof curbs, pitch pockets, concrete pads, and sleeved openings in walls, floors and ceilings as required providing unobstructed access from the Walk-In Cooler/Freezer Assemblies to the Remote Condensing Units at their final locations. Coordinate with the General Contractor.

ITEM # 5                      REMOTE CONDENSER UNIT FOR FREEZER, OUTDOORS

Quantity:                      Two (2)  
 Manufacturer:                Custom  
 Model:                         BALLY or equal as approved by the Professional

Two (2) Model BALLY Quote No: 220433-1-0-HND  
 BEZA 025 L8 HS2D (208-230/1/60) w/ smart speed  
 Includes defrost contactor for 1 Evap.

1. Refrigeration Systems shall be pre-assembled remote with condensing units supplied with all "in-Line" parts and controls including refrigeration lines, sight glass, drier, vibration eliminator, time clock (for all low temperature units).
2. All Outdoor Remote Condensers shall be supplied with base and weather cover and low ambient protection which shall consist of crankcase heaters, thermostat with solenoid valve (pump down) and head pressure control as low ambient protection for outdoor protection.
3. A qualified technician shall be required on site to accomplish installation, check-out and start-up procedures.
4. The KEC shall furnish & install the evaporator coils in the walk-in cooler/freezers.
5. The KEC shall furnish & install refrigeration lines.
6. The KEC shall be responsible installing/lifting, etc. the condensers to the roof or on grade as stated or if an indoor installation, install where shown on plans.
7. The General Contractor shall provide all roof curbs, pitch pockets, concrete pads, and sleeved openings in walls, floors and ceilings as required providing unobstructed access from the Walk-In Cooler/Freezer Assemblies to the Remote Condensing Units at their final locations. Coordinate with the General Contractor.

ITEM # 6                      SHELVING, WITH METAL FRAME    <By Owner>

Quantity:                      Fourty-Five (45)  
 Manufacturer:                Metro or equal as approved by the Professional  
 Model:                         MQ2454G

Fourty-Five (45) Model MQ2454G MetroMax® Q Shelf, 54"W x 24"D, removable open grid polymer shelf mats on an epoxy coated steel frame with quick adjust corner releases, (4) wedge connectors, Microban® antimicrobial product protection, 600 lb. capacity per shelf, NSF (THESE MAKE UP NINE (9) MOBILE SHELVING UNITS WITH FIVE SHELVES EACH)  
 Thirty-Six (36) Model MX86UP Polymer trilobal post (compatible with MetroMax® i, MetroMax® 4, MetroMax® Q), 85-3/16"H, for use with stem casters, adjusts at 1" increments, corrosion proof all polymer construction with built in Microban® antimicrobial product protection  
 Eighteen (18) Model 5MPXGSA Stainless Steel Cart-Washable Stem Caster, swivel, flat polyurethane wheel tread, 300 lb. capacity. NSF listed(for use with all MetroMax posts & shelves)  
 Eighteen (18) Model 5MPBXGSA Stainless Steel Cart-Washable Stem Caster, brake, flat polyurethane wheel tread, 300 lb. capacity, NSF (for use with all MetroMax posts & shelves)

ITEM # 7 SHELIVING, WITH METAL FRAME <By Owner>

Quantity: Thirty-Five (35)  
Manufacturer: Metro or equal as approved by the Professional  
Model: MQ2442G

Thirty-Five (35) Model MQ2442G MetroMax® Q Shelf, 42"W x 24"D, removable open grid polymer shelf mats on an epoxy coated steel frame with quick adjust corner releases, (4) wedge connectors, Microban® antimicrobial product protection, 800 lb. capacity per shelf, NSF (THESE MAKE UP TWELVE (12) MOBILE SHELIVING UNITS WITH FIVE SHELVES EACH)  
Twenty-Eight (28) Model MX86UP Polymer trilobal post (compatible with MetroMax® i, MetroMax® 4, MetroMax® Q), 85-3/16"H, for use with stem casters, adjusts at 1" increments, corrosion proof all polymer construction with built in Microban® antimicrobial product protection  
Fourteen (14) Model 5MPXGSA Stainless Steel Cart-Washable Stem Caster, swivel, flat polyurethane wheel tread, 300 lb. capacity. NSF listed(for use with all MetroMax posts & shelves)  
Fourteen (14) Model 5MPBXGSA Stainless Steel Cart-Washable Stem Caster, brake, flat polyurethane wheel tread, 300 lb. capacity, NSF (for use with all MetroMax posts & shelves)  
(10) Model MQ2448G MetroMax® Q Shelf, 48"W x 24"D, removable open grid polymer shelf mats on an epoxy coated steel frame with quick adjust corner releases, (4) wedge connectors, Microban® antimicrobial product protection, 800 lb. capacity per shelf, NSF  
Eight (8) Model MX86UP Polymer trilobal post (compatible with MetroMax® i, MetroMax® 4, MetroMax® Q), 85-3/16"H, for use with stem casters, adjusts at 1" increments, corrosion proof all polymer construction with built in Microban® antimicrobial product protection  
Four (4) Model 5MPXGSA Stainless Steel Cart-Washable Stem Caster, swivel, flat polyurethane wheel tread, 300 lb. capacity. NSF listed(for use with all MetroMax posts & shelves)  
Four (4) Model 5MPBXGSA Stainless Steel Cart-Washable Stem Caster, brake, flat polyurethane wheel tread, 300 lb. capacity, NSF (for use with all MetroMax posts & shelves)  
Five (5) Model MQ2454G MetroMax® Q Shelf, 54"W x 24"D, removable open grid polymer shelf mats on an epoxy coated steel frame with quick adjust corner releases, (4) wedge connectors, Microban® antimicrobial product protection, 600 lb. capacity per shelf, NSF  
Four (4) Model MX86UP Polymer trilobal post (compatible with MetroMax® i, MetroMax® 4, MetroMax® Q), 85-3/16"H, for use with stem casters, adjusts at 1" increments, corrosion proof all polymer construction with built in Microban® antimicrobial product protection  
Two (2) Model 5MPXGSA Stainless Steel Cart-Washable Stem Caster, swivel, flat polyurethane wheel tread, 300 lb. capacity. NSF listed(for use with all MetroMax posts & shelves)  
Two (2) Model 5MPBXGSA Stainless Steel Cart-Washable Stem Caster, brake, flat polyurethane wheel tread, 300 lb. capacity, NSF (for use with all MetroMax posts & shelves)  
(10) Model MQ2460G MetroMax® Q Shelf, 60"W x 24"D, removable open grid polymer shelf mats on an epoxy coated steel frame with quick adjust corner releases, (4) wedge connectors, Microban® antimicrobial product protection, 600 lb. capacity per shelf, NSF  
Eight (8) Model MX86UP Polymer trilobal post (compatible with MetroMax® i, MetroMax® 4, MetroMax® Q), 85-3/16"H, for use with stem casters, adjusts at 1" increments, corrosion proof all polymer construction with built in Microban® antimicrobial product protection  
Four (4) Model 5MPXGSA Stainless Steel Cart-Washable Stem Caster, swivel, flat polyurethane wheel tread, 300 lb. capacity. NSF listed(for use with all MetroMax posts & shelves)  
Four (4) Model 5MPBXGSA Stainless Steel Cart-Washable Stem Caster, brake, flat polyurethane wheel tread, 300 lb. capacity, NSF (for use with all MetroMax posts & shelves)

ITEM # 8 MOBILE DUNNAGE RACK <By Owner>

Quantity: Three (3)  
Manufacturer: Metro or equal as approved by the Professional  
Model: MHP55S

Three (3) Model MHP55S Dunnage Rack, mobile, 24" x 48" (2) swivel & swivel/brake casters, 800 lb capacity, non-marking polyurethane tread, 1" square tubing, removable mat 5/16"D wire, designed only for 5HP & 5HPB casters, comes assembled with the special posts, stainless steel, NSF

ITEM # 9                      BUSSING UTILITY TRANSPORT CART, METAL   <By Owner>

Quantity:                      Two (2)  
Manufacturer:                Lakeside Manufacturing or equal as approved by the Professional  
Model:                         243

Two (2) Model 243 Utility Cart, 2-shelf with 36"W x 22"D x 40-5/8"H, shelf size 33"W x 21"D, stainless steel tubular U-frame, 20 gauge stainless steel shelves with reinforced edges, 500 lb. capacity, 21-1/2" shelf clearance, push handle on each short side, 5" non-marking cushion thread swivel casters, NSF (ships fully assembled), Made in USA  
Two (2) Casters, Lake-Glide, 5" (2 brake)  
Two (2) Round corner bumpers (set of 4)

ITEM # 13                     CAN RACK   <By Owner>

Quantity:                      Three (3)  
Manufacturer:                New Age or equal as approved by the Professional  
Model:                         1256CK

Three (3) Model 1256CK Can Storage Rack, mobile design with casters, sloped glides for automatic can retrieval, aluminum construction, holds 216-#10 or 297-#5 cans, (4) 6" plate casters, (2) swivel with brakes, (2) rigid, NSF, Made in USA  
Three (3) Lifetime warranty against rust & corrosion, 5 year workmanship and material defects warranty, standard

ITEM # 14                     MOBILE DUNNAGE RACK   <By Owner>

Quantity:                      One (1)  
Manufacturer:                Metro or equal as approved by the Professional  
Model:                         MHP55S

One (1) Model MHP55S Dunnage Rack, mobile, 24" x 48" (2) swivel & swivel/brake casters, 800 lb capacity, non-marking polyurethane tread, 1" square tubing, removable mat 5/16"D wire, designed only for 5HP & 5HPB casters, comes assembled with the special posts, stainless steel, NSF  
One (1) Model MHP53S Dunnage Rack, mobile, 24" x 36" (2) swivel & swivel/brake casters, 800 lb capacity, non-marking polyurethane tread, 1" square tubing, removable mat 5/16"D wire, designed only for 5HP & 5HPB casters, comes assembled with the special posts, stainless steel, NSF

ITEM # 15                     SHELVING, WITH METAL FRAME   <By Owner>

Quantity:                      Thirty-Five (35)  
Manufacturer:                Metro or equal as approved by the Professional  
Model:                         MQ2454G

Thirty-Five (35) Model MQ2454G MetroMax® Q Shelf, 54"W x 24"D, removable open grid polymer shelf mats on an epoxy coated steel frame with quick adjust corner releases, (4) wedge connectors, Microban® antimicrobial product protection, 600 lb. capacity per shelf, NSF (THESE MAKE UP SEVEN (7) MOBILE SHELVING UNITS WITH FIVE SHELVES EACH)  
 Twenty-Eight (28) Model MX86UP Polymer trilobal post (compatible with MetroMax® i, MetroMax® 4, MetroMax® Q), 85-3/16"H, for use with stem casters, adjusts at 1" increments, corrosion proof all polymer construction with built in Microban® antimicrobial product protection  
 Fourteen (14) Model 5MPXGSA Stainless Steel Cart-Washable Stem Caster, swivel, flat polyurethane wheel tread, 300 lb. capacity. NSF listed(for use with all MetroMax posts & shelves)  
 Fourteen (14) Model 5MPBXGSA Stainless Steel Cart-Washable Stem Caster, brake, flat polyurethane wheel tread, 300 lb. capacity, NSF (for use with all MetroMax posts & shelves)

ITEM # 16                      WORK TABLE, STAINLESS STEEL TOP   <By Owner>

Quantity:                      One (1)  
 Manufacturer:                Eagle Group or equal as approved by the Professional  
 Model:                         T3096SE

One (1) Model T3096SE Spec-Master® Series Work Table, 96"W x 30"D, 14/300 series stainless steel top, rolled edge on front & back, adjustable 18/300 series stainless steel undershelf with marine edge, Uni-Lok® gusset system, (6) stainless steel legs & adjustable bullet feet, NSF

ITEM # 17                      SHELVING, WALL MOUNTED

Quantity:                      One (1)  
 Manufacturer:                Eagle Group or equal as approved by the Professional  
 Model:                         WS1296-14/3

One (1) Model WS1296-14/3 Shelf, wall-mounted, 96"W x 12"D, rolled frontedge, 1-1/2"H up-turn on sides & rear, includes stainless steel mounting brackets stud welded to shelf, 14/304 stainless steel construction, NSF

ITEM # 18                      SOILED LINEN CART - NIKEC   <By Owner>

ITEM # 19                      LINEN DRYER - NIKEC   <By Owner>

ITEM # 20                      LINEN WASHER - NIKEC   <By Owner>

ITEM # 21                      LAUNDRY TUB & FAUCET - NIKEC   <By Owner>

ITEM # 22                      MOP SINK

Quantity:                      One (1)  
 Manufacturer:                Eagle Group or equal as approved by the Professional  
 Model:                         F1916-12

One (1) Model F1916-12 Mop Sink, floor mount, 24-5/8"L x 21-1/2" W x 19-1/2"H overall, 20" wide x 16" front-to-back x 12" deep bowl, 16 gauge top with "V" edge, full skirt, 2" NPS drain with stainless steel removable strainer plate, 304 stainless steel construction, NSF  
One (1) Model 321561 Mop Holder, 24"W, holds (4) mops  
One (1) Model 312690 Service Faucet, with vacuum breaker, 8" OC, 1/2" NPT female inlets  
One (1) Model 503097 Splash Kit, 3" radius on front of splashes, left, right & rear splash, 16/304 stainless steel, hardware included, NSF (fits F1916 models)

ITEM # 23 MOP SERVICE FAUCET INCLUDED WITH ITEM 22 <Included>

ITEM # 24 MOP BROOM HOLDER

Quantity: One (1)  
Manufacturer: Eagle Group or equal as approved by the Professional  
Model: US0824-16/3-X

One (1) Model US0824-16/3-X Utility Shelf with Mop Hanger, 24"W x 8"D, includes mop hangers & hooks for clothes, 16/304 stainless steel construction (FLYER)

ITEM # 25 EYEWASH STATIONS - NIKEC <By G/C>

QUANTITIES AND LOCATIONS TO BE DETERMINED BY ARCHITECT.

ITEM # 26 HAND SINK

Quantity: (10)  
Manufacturer: Eagle Group or equal as approved by the Professional  
Model: HSA-10-FKP

(10) Model HSA-10-FKP Hand Sink, wall mount, 13-1/2" wide x 9-3/4" front-to-back x 6-3/4" deep bowl, 304 stainless steel construction, splash mount gooseneck spout, single knee pedal, skirt, basket drain, deep-drawn seamless design-positive drain, inverted "V" edge, NSF  
(10) Model -MG MicroGard™ antimicrobial finish on bowl only- add suffix "-MG" to end of hand sink model number

ITEM # 27 SOAP & TOWEL DISPENSERS - NIKEC <By Owner>

ITEM # 28 THREE (3) COMPARTMENT SINK

Quantity: One (1)  
Manufacturer: Eagle Group or equal as approved by the Professional  
Model: FN2860-3-30-14/3

One (1) Model FN2860-3-30-14/3 Spec-Master® FN Series Sink, three compartment, 126"W x 35"D, 14/304 stainless steel top, coved corners, 20" wide x 28" front-to-back x 14" deep compartments, 30" drainboards on left & right, 9-1/2"H backsplash with 1" upturn & tile edge, (2) sets of 8" OC splash mount faucet holes, rolled edges on front & sides, includes 3-1/2" basket drains, stainless steel crossbracing on all sides, stainless steel legs & adjustable bullet feet, NSF  
Three (3) Model 341190 Twist Handle Drain, with overflow, 2" NPS connection & overflow

Three (3) Model -OF Holes (3) for twist handle drain with overflow drain (drain not included), 3 compartment 412, 414 & 314 sinks  
Three (3) Model -TB Twist bracket, per drain

ITEM # 29 PRE-RINSE FAUCET ASSEMBLY, WITH ADD ON FAUCET

Quantity: One (1)  
Manufacturer: T&S Brass or equal as approved by the Professional  
Model: B-0133-18CRBJST

One (1) Model B-0133-18CRBJST EasyInstall Pre-Rinse Unit, 8" wall mount, add on faucet 18" swing nozzle with stream regulator (B-0107-J), quarter-turn cerama cartridges with check valves, lever handles, 44" flexible stainless steel hose, 1.07 GPM, installation kit, 6" wall bracket, accessory fitting tee, 1/2" NPT female inlet, low lead, NSF  
One (1) 3 year limited warranty, standard

ITEM # 30 WALL / SPLASH MOUNT FAUCET

Quantity: One (1)  
Manufacturer: T&S Brass or equal as approved by the Professional  
Model: B-0291

One (1) Model B-0291 Kettle & Pot Sink Faucet, Big-Flo, wall mounted 8" centers, 3/4" IPS model LL street EL inlets with locknuts, 18" swing nozzle, 175°F four arm handles, 1-1/4" dia. holes required in backsplash  
Two (2) Model B-0427 Supply Nipple, 3/4" x 2-1/2"  
One (1) Order in quantities of (2) per faucet

ITEM # 31 POT RACK

Quantity: One (1)  
Manufacturer: Eagle Group or equal as approved by the Professional  
Model: WM60PR

One (1) Model WM60PR Pot Rack, wall mount, 60"W x 12"D x 16"H, double-bar design, constructed of 3/16" x 2" stainless steel flat bar, includes (10) double-pronged pot hooks, NSF

ITEM # 32 POT RACK

Quantity: One (1)  
Manufacturer: Eagle Group or equal as approved by the Professional  
Model: WM36PR

One (1) Model WM36PR Pot Rack, wall mount, 36"W x 12"D x 16"H, double-bar design, constructed of 3/16" x 2" stainless steel flat bar, includes (6) double-pronged pot hooks, NSF

ITEM # 33 SHELVING, WITH METAL FRAME <By Owner>

Quantity: (10)  
Manufacturer: Metro or equal as approved by the Professional  
Model: MQ2454G

(10) Model MQ2454G MetroMax® Q Shelf, 54"W x 24"D, removable open grid polymer shelf mats on an epoxy coated steel frame with quick adjust corner releases, (4) wedge connectors, Microban® antimicrobial product protection, 600 lb. capacity per shelf, NSF  
 (THESE MAKE UP TWO (2) MOBILE SHELVING UNITS WITH FIVE SHELVES EACH)  
 Eight (8) Model MX86UP Polymer trilobal post (compatible with MetroMax® i, MetroMax® 4, MetroMax® Q), 85-3/16"H, for use with stem casters, adjusts at 1" increments, corrosion proof all polymer construction with built in Microban® antimicrobial product protection  
 Four (4) Model 5MPXGSA Stainless Steel Cart-Washable Stem Caster, swivel, flat polyurethane wheel tread, 300 lb. capacity. NSF listed(for use with all MetroMax posts & shelves)  
 Four (4) Model 5MPBXGSA Stainless Steel Cart-Washable Stem Caster, brake, flat polyurethane wheel tread, 300 lb. capacity, NSF (for use with all MetroMax posts & shelves)

ITEM # 34                      HOSE REEL

Quantity:                      One (1)  
 Manufacturer:                T&S Brass or equal as approved by the Professional  
 Model:                         B-1432-01

One (1) Model B-1432-01 Hose Reel Assembly, open, 3/8" x 35 ft. hose, 3" concealed mixing faucet, Eterna cartridges, lever handles with color coded indexes, continuous pressure vacuum breaker, 36" flexible water hose connector with stainless steel quick disconnect, high flow blue spray valve, with ratcheting system, 2-3/8" wall bracket, epoxy coated metal hose reel, 3/8" NPT  
 One (1) 1 year limited warranty, standard  
 One (1) 1 year limited warranty for hose, standard  
 One (1) 2 year limited warranty for hose reel, standard

ITEM # 35                      SPARE NO. <Spare No.>

ITEM # 36                      RACK DOLLY <By Owner>

Quantity:                      Eight (8)  
 Manufacturer:                Metro or equal as approved by the Professional  
 Model:                         DH2020N

Eight (8) Model DH2020N Dish Rack Dolly, platform design, single stack, designed for 20" x 20" racks, tubular steel handle, 5" Heavy duty, non-marking, resilient tread swivel casters, bumper corners, all aluminum construction, with handle

ITEM # 37                      CLEAN DISHTABLE

Quantity:                      One (1)  
 Manufacturer:                Eagle Group or equal as approved by the Professional  
 Model:                         CDTR-72-14/3

One (1) Model CDTR-72-14/3 Spec-Master® Clean Dishtable, straight design, 72"W x 30"D x 43-1/2"H overall, left-to-right operation, 14/304 stainless steel top, 8"H backsplash, raised rolled edges on front & side, stainless steel legs & crossbracing, adjustable metal feet, NSF  
 One (1) Model E120 Table limit switch provision (switch by others)



ITEM # 38                    DISH CART / DOLLY   <By Owner>

Quantity:                    Four (4)  
Manufacturer:                Metro or equal as approved by the Professional  
Model:                        PCD11A

Four (4) Model PCD11A Poker Chip Dish Dolly, 26-5/8"W x 26-5/8"D x 31-15/16"H, adjustable, dish size 4-1/4" to 11-3/4", removable dividers & towers, two-handed access, recessed handles, 5"Dia. swivel casters with neoprene wheels (2 with brakes), chip-resistant polymer shell with Microban® antimicrobial protection, aesthetic blue, vinyl dust/water splash cover, NSF

ITEM # 39                    DISHTABLE SORTING SHELF

Quantity:                    One (1)  
Manufacturer:                Eagle Group or equal as approved by the Professional  
Model:                        605382

One (1) Model 605382 Slanted Rack Shelf, solid, wall mount, 63"W x 19-3/4"D x 21-3/8"H, stainless steel wall brackets, stainless steel drip tube (left side), 16/304 stainless steel construction

ITEM # 40                    DISHWASHER, CONVEYOR TYPE, VENTLESS

Quantity:                    One (1)  
Manufacturer:                Hobart or equal as approved by the Professional  
Model:                        CLPS66ENVL+BUILDUP

One (1) Model CLPS66ENVL+BUILDUP Ventless Conveyor Dishwasher, heat pump energy recovery operation, 22" power scrapper, single tank, (202) racks/hour, Opti-Rinse™ system, insulated hinged cabinet-style doors with door interlock switches, door actuated drain closure, pressure reducing valve, self-aligning wash manifolds, stainless steel anti-clogging wash arms, removable pump intake screen, stainless steel self-draining pump & impeller, (1) scrap screen & basket, 19-1/2"H chamber accommodates (6) sheet pans, 0.62 gallon/rack, stainless steel enclosure panels, NSF rated pot and pan mode, programmable microprocessor controls with low temperature, dirty water, and de-lime notification, 30kW stainless booster heater, 9kW wash tank heater, 4 HP compressor, 1/6 HP drive, 2 HP wash, 2 HP power scrapper, 1/6 HP heat pump fan, ENERGY STAR® (heat pump ships separately) (LEFT TO RIGHT OPERATION)  
Provide 480 volt - 3 phase connections.  
Dishwasher, 480v-3p, 26.3 amps,  
Booster heater, 480v-3p, 40.1 amps.

ITEM # 41                    DISHTABLE, SOILED "L" SHAPED

Quantity:                    One (1)  
Manufacturer:                Eagle Group or equal as approved by the Professional  
Model:                        SDTLL-84-14/3

One (1) Model SDTLL-84-14/3 Spec-Master® Soiled Dishtable, island design with dish landing shelf, 72" machine to corner, 60" corner to end, 30" working depth, 43-1/2"H overall, left-to-right operation, 14/304 stainless steel top, 60"W x 12"D dish landing shelf with rolled front edge, 8"H backplash, 20" x 20" x 5" deep pre-rinse sink with basket drain, (1) deck mount faucet hole for pre-rinse, includes scrap block, raised rolled edges on front & side, stainless steel legs & side bracing, adjustable feet, NSF

(PROVIDE SHOP DRAWING FOR REVIEW AND APPROVAL)

Four (4) Model E100 Additional Top length, NSF construction, per linear foot - APPROX. 8'-2"  
One (1) Model 606295 Double Sided Sorting Shelf, tubular, table mount (1" OD tubular uprights)  
& end wall mount, 60"W x 30.875"D x 33.375"H, use for soiled dishtables with landing shelf or  
with center island design, 1.625"dia. tubing, 16/304 stainless steel construction

(SORTING SHELF TO MATCH LENGTH OF DISHTABLE - APPROX. 8'-2")

One (1) Model 606434 Pre-rinse Basket, 17-1/2"W x 19-1/2"L x 2"H, with slide bar, for  
dishtables, 304 type stainless steel

One (1) Model SCRAP TROUGH Scrap Trough, 5"W x 2"D, 1-1/2" center drain opening,  
removable basket with handles, stainless steel construction

(PROVIDE CUTOUT/INSTALL PER MANUFACTURER'S RECOMMENDATIONS FOR WASTE  
COLLECTOR, ITEM 43 AS SHOWN ON PLANS)

ITEM # 42 PRE-RINSE FAUCET ASSEMBLY, WITH ADD ON FAUCET

Quantity: One (1)  
Manufacturer: T&S Brass or equal as approved by the Professional  
Model: B-0113-ADF10-BR

One (1) Model B-0113-ADF10-BR EasyInstall Pre-Rinse Unit, single hole deck mount, 10" add-  
on faucet, 1.15 GPM spray valve (B-0107) with brush attachment, 44" flexible stainless steel  
hose, 36" flexible supply lines, supply hose-stops-elbows, wall bracket, quarter-turn Eterna  
cartridges, low lead, 2019 DOE PRSV - Class II

ITEM # 43 WASTE COLLECTOR

Quantity: One (1)  
Manufacturer: InSinkErator or equal as approved by the Professional  
Model: PRS

One (1) Model PRS PowerRinse® Standard (Model PRS™) - Complete Waste Collection  
System Package. Requires only 1 GPM (3.79 LPM) of fresh water per hour. Pre-rinse and  
scrapping system with 30 GPM (113.56 LPM) recirculated water flow capability, dry start  
protection, and adjustable run time. Pre-plumbed and pre-wired base assembly with control,  
solenoid and pump; integrated air gap; stainless steel mounting tray, base assembly, cover,  
pump housing, 1/4" pump inlet screen, and pump impeller; 1/4" perforated scrap basket with four  
ergonomic handles; flanged feet; check valves; 2" drain discharge; 1/2" NPT water inlets.

One (1) Model PRS-2 208/220-240v/60/1-ph

One (1) Model COVER Cover, stainless steel, maximizes workspace for scrapping and pre-  
soaking problem dishes with baked-on or difficult to remove food (15426)

ITEM # 44 TRASH CONTAINERS - NIKEC <By Owner>

ITEM # 45 RECYCLING CONTAINERS - NIKEC <By Owner>

ITEM # 46 WORK TABLE, STAINLESS STEEL TOP <By Owner>

Quantity: Three (3)  
Manufacturer: Eagle Group or equal as approved by the Professional  
Model: T3696SEM

Three (3) Model T3696SEM Spec-Master® Marine Series Work Table, 96"W x 36"D, 14/300 series stainless steel top, box marine edge on all sides, adjustable 18/300 series stainless steel undershelf with marine edge, Uni-Lok® gusset system, (6) stainless steel legs & adjustable bullet feet, NSF

Six (6) Model 502946 Drawer Assembly, 20" x 20" x 5", 430 type stainless steel housing & frame, removable drawer pan, NSF approved removable slides, hemmed safety pull handle

Three (3) Model CA6-SB Table Casters, set of (6), 4" diameter, (3) swivel & (3) swivel/brake, 115 lbs. capacity per caster, zinc with resilient tread, NSF

ITEM # 47                      BLIXER   <By Owner>

Quantity:                      Two (2)

Manufacturer:                Robot Coupe or equal as approved by the Professional

Model:                         BLIXER10

Two (2) Model BLIXER10 Blixer® Commercial Blender/Mixer, vertical, 11.5 liter capacity, stainless steel bowl with handle, (3) blade adjustable stainless steel Blixer® assembly, pulse switch, two speed 1800 & 3600 RPM, 11.0 amps, 4-1/2 HP, 208-240v/60/3-ph, NEMA L15-20P, cETLus, ETL-Sanitation

Two (2) 1 year parts & labor warranty

ITEM # 48                      PLANETARY MIXER   <By Owner>

Quantity:                      One (1)

Manufacturer:                Hobart or equal as approved by the Professional

Model:                         HL200-1STD

One (1) Model HL200-1STD 100-120/50/60/1; Bench type mixer; with bowl, beater, whip & spiral dough arm, US/EXP configuration - Legacy Planetary Mixer, Bench, 20 quart, (3) fixed speeds plus stir speed, gear-driven transmission, 15-minute SmartTimer™, #12 taper hub, manual bowl lift, stainless steel bowl, aluminum "B" beater, stainless steel "D" wire whip, aluminum "ED" spiral dough arm, stainless steel bowl guard, 1/2 hp, cord with plug

One (1) Standard warranty - 1-Year parts, labor & travel time during normal working hours within the USA

ITEM # 49                      WORK TABLE, STAINLESS STEEL TOP

Quantity:                      One (1)

Manufacturer:                Eagle Group or equal as approved by the Professional

Model:                         T3696SEM

One (1) Model T3696SEM Spec-Master® Marine Series Work Table, 96"W x 36"D, 14/300 series stainless steel top, box marine edge on all sides, adjustable 18/300 series stainless steel undershelf with marine edge, Uni-Lok® gusset system, (6) stainless steel legs & adjustable bullet feet, NSF

(KITCHEN EQUIPMENT CONTRACTOR SHALL PROVIDE HOLES IN UNDERSHELF WHERE REQUIRED FOR DRAIN LINES TO EXTEND TO FLOOR SINK)

Two (2) Model E23 Sink, 16" x 20" x 14" bowl, for 30"W tables, complete with faucet & basket drain (specify location)

Two (2) Model 300721 Lever Handle Drain, 2" IPS connection

One (1) Model 300692 Bullet Feet, stainless steel, each

ITEM # 50 DECK MOUNT FAUCET

Quantity: One (1)  
Manufacturer: T&S Brass or equal as approved by the Professional  
Model: B-1123

One (1) Model B-1123 Faucet, 12" swing nozzle, deck mounted, quarter-turn Eterna cartridges, lever handles, low lead, ADA Compliant

ITEM # 51 FOOD PROCESSOR, BENCHTOP / COUNTERTOP <By Owner>

Quantity: Two (2)  
Manufacturer: Robot Coupe or equal as approved by the Professional  
Model: R301UB

Two (2) Model R301UB D Series Cutter/Mixer, 3.7 liter stainless steel bowl with handle & see-thru lid, includes: (1) "S" blade with smooth edges, on/off & pulse switch, single speed, 1725 RPM, 120v/60/1-ph, 12.0 amps, 1-1/2 HP, NEMA 5-15P, cETLus, ETL-Sanitation  
Two (2) 1 year parts & labor warranty

ITEM # 52 ELECTRIC FOOD CUTTER <By Owner>

Quantity: One (1)  
Manufacturer: Hobart or equal as approved by the Professional  
Model: 84145-1

One (1) Model 84145-1 Food Cutter with #12 attachment hub, 14" diameter stainless steel bowl 22 RPM, double stainless steel knives 1725 RPM, bowl cover with safety interlock, push/pull on/off switch, one-piece burnished aluminum housing, 3" legs, 115v/60/1-ph, 1/2 HP  
One (1) Standard warranty - 1-Year parts, labor & travel time during normal working hours within the USA

ITEM # 53 SPARE NO. <Spare No.>

ITEM # 54 SPARE NO. <Spare No.>

ITEM # 55 WORK TABLE, STAINLESS STEEL TOP <By Owner>

Quantity: One (1)  
Manufacturer: Eagle Group or equal as approved by the Professional  
Model: T3696SEM

One (1) Model T3696SEM Spec-Master® Marine Series Work Table, 96"W x 36"D, 14/300 series stainless steel top, box marine edge on all sides, adjustable 18/300 series stainless steel undershelf with marine edge, Uni-Lok® gusset system, (6) stainless steel legs & adjustable bullet feet, NSF  
One (1) Model TM96APR Pot Rack, table mount, 88"W x 20"D, triple-bar design with tubular table supports, constructed of 3/16" x 2" aluminum flat bar, includes (24) double-pronged pot hooks, for 96"W table, NSF  
One (1) Model 502946 Drawer Assembly, 20" x 20" x 5", 430 type stainless steel housing & frame, removable drawer pan, NSF approved removable slides, hemmed safety pull handle

One (1) Model 300692 Bullet Feet, stainless steel, each

ITEM # 56                      SPARE NO.   <Spare No.>

ITEM # 57                      MEGA SANDWICH / SALAD PREPARATION REFRIGERATOR   <By Owner>

Quantity:                      Two (2)  
Manufacturer:                  Continental Refrigerator or equal as approved by the Professional  
Model:                              D60N24M-D

Two (2) Model D60N24M-D Designer Line Mighty Top Sandwich Unit, 60"W, two-section, (24) 1/6 size x 4" deep pans with 8" cutting board, (4) drawers, accommodates (1) 12 x 20 x 6 pan per drawer (supplied by others), stainless steel top, front, sides & interior, electronic control with digital display, hi-low alarm, 6" adjustable legs, rear mounted self-contained refrigeration, automatic hot gas condensate evaporator, R290 Hydrocarbon Refrigerant, 1/3 HP  
Two (2) Standard warranty (for the United States & Canada Only): 3 year parts and labor; additional 4 year compressor part  
Two (2) 115v/60/1-ph, 5.8 amps, cord, NEMA 5-15P, standard  
Two (2) Stainless steel finished back  
Two (2) Model 50301 Casters, swivel, with brakes (3" diameter rubber tires) set of 4 (3-3/4" height)

ITEM # 58                      WORK TABLE, STAINLESS STEEL TOP

Quantity:                      One (1)  
Manufacturer:                  Eagle Group or equal as approved by the Professional  
Model:                              T3696SEM

One (1) Model T3696SEM Spec-Master® Marine Series Work Table, 96"W x 36"D, 14/300 series stainless steel top, box marine edge on all sides, adjustable 18/300 series stainless steel undershelf with marine edge, Uni-Lok® gusset system, (6) stainless steel legs & adjustable bullet feet, NSF  
One (1) Model TM96APR Pot Rack, table mount, 88"W x 20"D, triple-bar design with tubular table supports, constructed of 3/16" x 2" aluminum flat bar, includes (24) double-pronged pot hooks, for 96"W table, NSF  
One (1) Model E23 Sink, 16" x 20" x 14" bowl, for 30"W tables, complete with faucet & basket drain (specify location)  
One (1) Model 300721 Lever Handle Drain, 2" IPS connection  
One (1) Model 300692 Bullet Feet, stainless steel, each

ITEM # 59                      DECK MOUNT FAUCET

Quantity:                      One (1)  
Manufacturer:                  T&S Brass or equal as approved by the Professional  
Model:                              B-1123

One (1) Model B-1123 Faucet, 12" swing nozzle, deck mounted, quarter-turn Eterna cartridges, lever handles, low lead, ADA Compliant

ITEM # 60                      SPARE NO.   <Spare No.>

ITEM # 61                    SPARE NO.   <Spare No.>

ITEM # 62                    SPARE NO.   <Spare No.>

ITEM # 63                    FOOD SLICER, ELECTRIC   <By Owner>

Quantity:                    One (1)  
Manufacturer:                Hobart or equal as approved by the Professional  
Model:                        EDGE13A-11

One (1) Model EDGE13A-11 Centerline by Hobart Edge Series Slicer, automatic, single speed, single stroke length, med duty, angle feed, 13" chrome plated carbon steel knife, carriage & gauge interlocks, no volt release, poly-v belt drive system, anodized aluminum carriage & knife cover, top mounted sharpener, anodized aluminum finish, 120v/60/1-ph, 4.0 mp, 1/2 hp, cETLus, NEMA 5-15P, NSF (NET)  
One (1) Standard warranty - 1-Year parts, labor & travel time during normal working hours within the USA

ITEM # 64                    REACH-IN FREEZER   <By Owner>

Quantity:                    One (1)  
Manufacturer:                Continental Refrigerator or equal as approved by the Professional  
Model:                        2FNHD

One (1) Model 2FNHD Freezer, reach-in, two-section, self-contained refrigeration, stainless steel front, aluminum interior & ends, standard depth, half-height solid doors, cylinder locks, electronic control with digital display, unit can be adjusted to operate as low as -10°F, hi-low alarm, electric condensate evaporator, R290 Hydrocarbon refrigerant, 1/2 HP, cETLus, NSF, Made in USA, ENERGY STAR®  
One (1) Standard warranty (for the United States & Canada Only): 3 year parts and labor; additional 4 year compressor part  
One (1) 115v/60/1-ph, 9.0 amps, cord, NEMA 5-15P, standard  
One (1) Left Door hinged on left & right door hinged on right, standard  
One (1) 5" Casters, standard

ITEM # 65                    EXHAUST HOOD

Quantity:                    One (1)  
Manufacturer:                Captive-Aire or equal as approved by the Professional

One (1) 1. Kitchen Equipment Contractor shall furnish all thread rod, uni-strut and materials required to hang the exhaust hood(s) from the overhead structure. If any modifications are required to the overhead structure, coordinate with the General Contractor. The General Contractor shall provide any needed modifications to the building structure.  
2. Kitchen Equipment Contractor shall deliver the Exhaust & MUA Fans and roof curbs to the General Contractor at the jobsite. Installation of the roof curbs and fans are by the General Contractor including any cranes, rigging, operators, etc.  
3. U.L. listed, NSF approved, incandescent light fixtures equally spaced per section, pre-wired to common junction box. (1) One set of bulbs furnished and installed by K.E.C.  
4. Stainless steel closure panels from top of hood to finished ceiling by K.E.C. (K.E.C. to verify height)  
5. Surface fire protection system nozzles and piping to be installed at factory when fabricated with

- all exposed pipes and fittings in chrome plating or stainless steel.
- 6. Hood to have stainless steel hanger brackets welded to top of hood sections as required.
- 7. Full length make up air plenum along front of hood.
- 8. Provide Air Conditioned & Heated MUA Fan to provide tempered make up air.
- 9. All ductwork to be furnished and installed in accordance with all codes & regulations by the Mechanical Contractor and is not in the Kitchen Equipment Contract.
- 10. See Sheets QK-500 through QK-509 of the Contract Food Service Drawings.
- 11. Provide manufacturers shop drawings for review and approval.

ITEM # 66                      FIRE SUPPRESSION SYSTEM

Quantity:                      One (1)  
 Manufacturer:                Captive-Aire or equal as approved by the Professional  
 Model:                         TANK

One (1) Model TANK Ansul Fire Suppression System;

1. Surface nozzles, hood and duct protection nozzles to be in Ventilator, Item# 65.
  2. Manual pull station and micro switch with one set of normally open and one set of normally closed contact points.
  3. All exposed piping, fittings, control center and storage tanks to be chrome plated or stainless steel.
  4. Six month and twelve month inspections, servicing, and replacement of components as per NFPA-96 latest edition.
  5. All components and labor necessary for a complete system in accordance with NFPA-96 latest edition, OSHA, and all applicable codes.
  6. System shall include One (1) gas solenoid valve(electric or mechanical as required) which shall be installed per local codes by Plumbing Contractor and interwired by Electrical Contractor if applicable. If a second gas valve is required by Codes, this is to be included in the Kitchen Equipment Contract.
  7. Final installation and final testing by factory authorized Ansul agency.
  8. This Authorized and Certified Fire Suppression System Contractor shall provide and install all electrical control interlocks required per NFPA 17A, NFPA 96 and all local codes, standards and regulations associated with fire suppression system installation. Wiring shall include necessary control interlocks from fire system micro switch to; exhaust and make up air fan motor control panel(s), electrical gas solenoid By Pass valve(s), commercial building fire alarm system, electrical disconnects and or shunt trip breaker controls as required per local jurisdiction having authority.
  9. Electrical Division 16 to provide and install necessary shunt trip breakers or disconnects, fire alarm system modules, devises and or programming, and all required power circuitry associated with cooking equipment and fan units.
- A. A pre-engineered, fixed pipe, automatic wet chemical agent fire suppression system for protection of all hazard areas associated with cooking operations, including exhaust hoods, plenums, ductwork, and cooking appliances.
  - B. Exhaust hood fire system components to be factory installed.
  - C. Cylinder and Valve Assembly
    1. The cylinders shall have a tin-nickel alloy plated brass valve with pressure gauge.
    2. Wet chemical agent shall be contained in one or more stored pressure DOT/TC rated steel cylinder and valve assemblies.
    3. Each cylinder is factory-filled with liquid fire suppressant and pressurized to 200 PSIG at 70°F.
  - D. Distribution Nozzles

1. Nozzles shall be located to protect the exhaust ducts, plenums, and all cooking appliances requiring protection.
2. All nozzles shall be equipped with a metal blow off cap. The cap prevents contamination from entering the pipe network and is designed to pop-off upon system discharge, allowing agent to flow to the protected hazard area.
3. All nozzles shall incorporate a stamped part number to easily identify nozzle type.

E. Distribution System

1. The distribution system shall consist of Copper, Schedule 40 black iron, chrome-plated or stainless-steel pipe and fittings. All exposed piping and fittings must be chrome-plated or stainless steel.
2. Fittings shall be minimum class 150. Galvanized fittings shall not be used.

F. Suppression System

1. The system control equipment shall be capable of all functions associated with automatically and manually discharging the wet chemical agent from all cylinder and valve assemblies, including automatic shutdown of the heat source or fuel and electrical power to all protected areas upon system discharge.
2. Liquid Fire Suppressant shall be Aqueous Potassium Carbonate (APC).
3. All mechanical components of the actuator kit shall be enclosed.
4. The actuator kit shall be capable of automatic or manual activation means.
5. Supervisory Pressure Switch added to monitor operating system pressure.
6. For manual activation, an electrically operated manual release shall be used to actuate the system manually.
7. For automatic activation, the system will be activated by a Firestat (heat) detector.
8. Electrical Division to provide shunt trip breakers at main power panel, or disconnects, as designated by the Electrical Engineer; interconnection provided at hood control panel for the signal to shut down all electricity in and under the exhaust hood. Shunt trips/disconnects to accomplish shut off of electricity in the event of fire system activation by others.
9. Printed circuit board with microprocessor-based controller that provides all the necessary monitoring, timing, and supervision functions required for the reliable operation of the fire system.
10. Independent supervised loops incorporate redundancy and fault detection.
11. Real-time cloud-based monitoring connection provided with system by ownership.
12. Primary power supply, with battery backup for power loss.
13. All wiring must be in accordance to NFPA 70 and the Authority Having Jurisdiction(AHJ).
14. Electric gas valve provided for equipment below exhaust hood. Coordinate size and installation with Plumbing Division.
15. All wiring is to be in accordance with the applicable manufacturer's instructions for the fire alarm control panel, gas shut-off valve, manual reset relay, and contractor supplied shut-off devices.

ITEM # 67                      FRYER BATTERY, GAS

Quantity:                      One (1)  
 Manufacturer:                Pitco Frialator or equal as approved by the Professional  
 Model:                            SG14RS-4FD



One (1) Model SG14RS-4FD Solstice™ Prepackaged Fryer System with Solstice™ Filter Drawer System, High Power, gas, (4) 50 lb. oil capacity full tanks, millivolt control, stainless steel tank, front & sides, under-fryer drawer filtration, total 488,000 BTU (-FFFF), NSF, CE, CSA Flame, CSA Star, AuGA  
 One (1) 1 year parts and labor warranty from the date of installation up to a maximum of 15 months from the date of manufacture (with appropriate documentation), standard  
 One (1) Natural gas  
 One (1) Millivolt Thermostat, standard  
 One (1) 115v/60/1-ph, 7.0 amps  
 One (1) Contact factory for cord information  
 One (1) Model P6072145 Basket, (2) oblong/twin size, 13-1/2" x 6-1/2" x 5-3/4" deep, long handle, regular mesh (shipped std (n/c) with models "T" SG14, SG14R, SSH55, SE14, SE14X, SE14B, SG14T, 35+, 45+, fryer batteries shipped with (1) per fryer  
 One (1) Model PP10613 Filter Paper, envelope, heavy duty, 18-1/2" x 20-1/2", 100 per pack  
 One (1) Model PP10733 Filter powder, (120) 2 oz. packets (8 oz. by volume)  
 One (1) Filter flush hose, each  
 One (1) Model PP10056 Fryer Cleaning Brush, high temperature  
 One (1) Model B7490701 Crumb Scoop, designed to fit between gas fryer tubes for removal of heavy sediment  
 One (1) Model PP10725 Skimmer- used for removing food particles from surface oil  
 One (1) Model B3901504 Casters, 9" adjustable swivel non-lock rear & lock front casters, for battery of (4) Solstice gas and electric fryers, batteries and retherms  
 One (1) Model B8003109 Gas Connector Hose, 1-1/4" connection, 48" long, with quick disconnect couplings, restraining device & thermal shut-off, for multiple units 575,000 BTU

ITEM # 68                      GRIDDLE, GAS, COUNTERTOP

Quantity:                      Two (2)  
 Manufacturer:                Magikitch'n or equal as approved by the Professional  
 Model:                            MKG-48-E

Two (2) Model MKG-48-E Griddle, countertop, gas, 47-3/4" W x 24" D cooking surface, 1" thick polished griddle plate, electric thermostat with matchless ignition, grease chute and box, front grease trough, 3" side splash, stainless steel, 4" removable legs, 120,000 BTU, 115v/50/60/1-ph, 0.88 amps, 6' cord, NEMA 5-15P, CSA, NSF  
 Two (2) 1 year limited parts and labor warranty, standard  
 Two (2) Natural gas, specify elevation if over 2000 feet  
 Two (2) Service shelf, 8" deep  
 Two (2) 48" x 3/4" Flexible gas hose with quick disconnect, restraining device & shut-off (Dormont)

ITEM # 69                      SPARE NO.    <Spare No.>

ITEM # 70                      EQUIPMENT STAND, FOR ITEM 68    <By Owner>

Quantity:                      Two (2)  
 Manufacturer:                Eagle Group or equal as approved by the Professional  
 Model:                            T3048SGS

Two (2) Model T3048SGS Griddle/Equipment Stand, 48-3/8"W x 30-3/8"D x 25-1/4"H, 16/300 stainless steel top, 1-1/4"H up-turn on sides & rear, open base with stainless steel adjustable undershelf, 1000 lbs weight capacity, Uni-Lok® gusset system, (4) stainless steel legs with adjustable white metal feet, NSF

Two (2) Model 307106 Cutting Board, equipment-mounted, 48"W x 8"D, 1-1/4" thick laminated hardwood, 1" diameter stainless steel tubular supports integrally welded to adjustable stainless steel sleeve assembly, NSF  
Two (2) Model CAH4-SB Table Casters, set of (4), 5" diameter, (2) swivel & (2) swivel/brake, 200 lbs. capacity per caster, zinc with resilient tread, NSF

ITEM # 71                      HD RANGE, 36", 4 OPEN BURNERS

Quantity:                      One (1)  
Manufacturer:                Jade Range or equal as approved by the Professional  
Model:                         JTRH-4-36

One (1) Model JTRH-4-36 Titan™ Heavy Duty Range, gas, 36", (4) 35,000 BTU open burners, infinite controls, standard oven, (2) chrome plated racks, stainless steel oven liner, 6" plate shelf, front, sides, stub back & bottom, 6" adjustable legs, 175,000 BTU, CSAus, NSF  
One (1) NOTE: All units are fully welded with heavy duty construction, stainless steel sides, front and top are standard  
One (1) NOTE: Stainless steel tray bed (burner box), deflectors, tray guides and drip tray/grease can standard  
One (1) Two years part & labor warranty - Includes Five year warranty parts on oven door (parts only) & Ten year warranty on range frame (parts only), standard  
One (1) Natural gas, specify if elevation over 2000 ft.  
One (1) 3/4" Rear connection, standard  
One (1) 3/4" Gas regulator supplied with range  
One (1) Cap & stainless steel manifold cover, left  
One (1) Cap & stainless steel manifold cover, right  
One (1) Model S-36 Titan™ 36" Single Deck High Shelf, stainless steel  
Three (3) Shelf deflector (coved bottom/Michigan-style), per ft  
One (1) Set of four casters (2 with brakes)  
One (1) 48" Long x 3/4" flex hose with quick disconnect

ITEM # 72                      CONVECTION OVEN, GAS

Quantity:                      One (1)  
Manufacturer:                Blodgett or equal as approved by the Professional  
Model:                         ZEPH-200-G DBL

One (1) Model ZEPH-200-G DBL Zephaire Convection Oven, gas, double-deck, bakery depth, capacity (5) 18" x 26" pans per compartment, (SSI-M) solid state infinite controls with 60 min. manual timer, two speed fan, flue connector, dependent glass doors, interior light, stainless steel front, sides and top, 6" stainless steel legs, 120,000 BTU, ETL, CE, NSF  
One (1) 2 year parts, 2 year labor and 1 additional year door warranty (parts only), standard  
One (1) Natural gas  
Two (2) 115v/60/1-ph, 6.0 amps, 2-wire with ground, cord & plug, 1/2 hp (per deck), standard  
One (1) Model SSI-D Top Oven: Solid State infinite with digital timer, standard  
One (1) Model SSI-D Bottom Oven: Solid State infinite with digital timer, standard  
One (1) Draft diverter, stainless steel, standard  
One (1) 6" plate casters (set)  
One (1) NOTE: DO NOT deduct cost of standard legs  
One (1) 48" flexible gas hose with quick disconnect & restraining device

ITEM # 73                      STAINLESS STEEL WALL PANELS UNDER HOOD

Quantity:                      One (1)  
Manufacturer:                Custom or equal as approved by the Professional  
Model:                         CUSTOM

One (1) Model CUSTOM Provide Stainless Steel Wall Cladding behind Exhaust Hood from floor tile base to up behind hood, approx. 24'-0" long. To be furnished and installed by the Kitchen Equipment Contractor. Provide all cut-outs as required for utilities with s/s escutcheons plates around any plumbing or gas lines. Provide outlet cut-outs sized so that outlet cover plates cover the cut-outs.  
Provide shop drawings for review and approvals.

ITEM # 74                      REACH-IN REFRIGERATOR   <By Owner>

Quantity:                      One (1)  
Manufacturer:                Continental Refrigerator or equal as approved by the Professional  
Model:                         2RN

One (1) Model 2RN Refrigerator, reach-in, two-section, self-contained refrigeration, stainless steel front, aluminum interior & ends, standard depth, full-height solid doors, cylinder locks, electronic control with digital display, hi-low alarm, unit comes standard with expansion valve, electric condensate evaporator, R290 Hydrocarbon Refrigerant, 1/3 HP, cETLus, NSF, Made in USA, ENERGY STAR®  
One (1) Standard warranty (for the United States & Canada Only): 3 year parts and labor; additional 4 year compressor part  
One (1) 115v/60/1-ph, 6.9 amps, cord, NEMA 5-15P, standard  
One (1) Left Door hinged on left & right door hinged on right, standard  
One (1) 5" Casters, standard

ITEM # 75                      SPARE NO.   <Spare No.>

ITEM # 76                      SPARE NO.   <Spare No.>

ITEM # 77                      PLANETARY MIXER   <By Owner>

Quantity:                      One (1)  
Manufacturer:                Hobart or equal as approved by the Professional  
Model:                         HL600-1STD

One (1) Model HL600-1STD 200-240/50/60/3/1 Mixer; with bowl, beater, "D" whip, & spiral dough arm; US/EXP configuration - Legacy Planetary Mixer, 2.7 HP, 60 quart, (4) fixed speeds, gear-driven transmission, 20-Minute SmartTimer™, #12 attach hub, power bowl lift, stainless steel bowl, stainless steel bowl guard, "B" beater, "D" wire whip, "ED" dough hook  
One (1) Standard warranty: 1-Year parts, labor & travel time during normal working hours within the USA

ITEM # 78                      WORK TABLE, BAKERS TOP   <By Owner>

Quantity:                      One (1)  
Manufacturer:                Eagle Group or equal as approved by the Professional

Model: MT3096ST-BS

One (1) Model MT3096ST-BS Work Table, baker's top, 96"W x 30"D, 1-3/4" thick hardwood top, 4"H splash on sides & rear, stainless steel gussets, stainless steel crossrails & tubular legs, adjustable stainless steel bullet feet, NSF  
One (1) Model 300692 Bullet Feet, stainless steel, each

ITEM # 79 INGREDIENT BIN <By Owner>

Quantity: Four (4)  
Manufacturer: Cambro or equal as approved by the Professional  
Model: IBS27148

Four (4) Model IBS27148 Ingredient Bin, mobile, 27 gallon capacity, 1-pc seamless polyethylene bin, 2-pc sliding polycarbonate lid, S-hook on front (scoop NOT included), (4) 3" heavy duty casters (2 front swivel, 2 fixed), white with clear cover, NSF  
Four (4) Model SCP12CW135 Camwear® Scoop, 12 oz., polycarbonate, clear, NSF  
Four (4) Model SCP24CW135 Camwear® Scoop, 24 oz., polycarbonate, clear, NSF

ITEM # 80 SHELVING, WALL MOUNTED

Quantity: One (1)  
Manufacturer: Eagle Group or equal as approved by the Professional  
Model: WS1296-14/3

One (1) Model WS1296-14/3 Shelf, wall-mounted, 96"W x 12"D, rolled frontedge, 1-1/2"H up-turn on sides & rear, includes stainless steel mounting brackets stud welded to shelf, 14/304 stainless steel construction, NSF  
One (1) Change shelf width to 15", replace 12 in model number with 15

ITEM # 81 BLAST CHILLER FREEZER, ROLL-IN

Quantity: One (1)  
Manufacturer: Infrico USA or equal as approved by the Professional  
Model: IBC-ABT201 CBI

One (1) Model IBC-ABT201 CBI Blast Chiller & Shock Freezer, roll-in, self-contained, 280 lb chilling/154 lb freezing capacity, single speed cart, compatible with (20) 12"x20"/18"x26" pans (not included), Interactive control panel with USB connection, 300 series stainless steel exterior & interior, chilling temperature range +194° F to +37° F in less than 90 minutes, freezing temperature range +194° F to - 0° F in less than 4 hours, loading ramp, stainless steel interior & exterior, (Compressor 4 HP, 220v/60/3-ph, 21 amps), (Controllers: 115v/60/1, 9.0 amps), cord only, HAACP Compliant, CE, cETLus, ETL-Sanitation  
One (1) Standard warranty: 2 year parts & labor warranty, standard  
One (1) Compressor warranty: Additional 4 year compressor warranty, standard  
One (1) 220v/60/3-ph, 21.0 amps, cord only, standard

ITEM # 82 BUN / SHEET PAN RACK <By Owner>

Quantity: Eight (8)  
Manufacturer: Metro or equal as approved by the Professional  
Model: RT115N

Eight (8) Model RT115N Pan Rack, mobile, end load, single section, 20-3/8"W x 64-1/8"H, 28"D, open sides, with slides for (11) 18" x 26" or (22) 14" x 18" pans, slides on 5" centers, riveted tubular aluminum frame, 5" swivel casters (2) with brake, KD, NSF

ITEM # 83                      ROLL-IN REFRIGERATOR   <By Owner>

Quantity:                      Two (2)  
Manufacturer:                Continental Refrigerator or equal as approved by the Professional  
Model:                         D2RIN

Two (2) Model D2RIN Designer Line Refrigerator, roll-in, two-section, self-contained refrigeration, stainless steel front, aluminum interior & ends, standard depth cabinet, full-height solid doors, cylinder locks, electronic control with digital display, hi-low alarm, unit comes standard with expansion valve, removable stainless steel ramps, R290 Hydrocarbon Refrigerant, 1/2 HP, cETLus, NSF, Made in USA  
Two (2) Standard warranty (for the United States & Canada Only): 3 year parts and labor; additional 4 year compressor part  
Two (2) 115v/60/1-ph, 9.4 amps, cord & plug, standard  
Two (2) Left Door hinged on left & right door hinged on right, standard

ITEM # 84                      EXHAUST HOOD

Quantity:                      One (1)  
Manufacturer:                Captive-Aire or equal as approved by the Professional

- One (1) 1. Kitchen Equipment Contractor shall furnish all thread rod, uni-strut and materials required to hang the exhaust hood(s) from the overhead structure. If any modifications are required to the overhead structure, coordinate with the General Contractor. The General Contractor shall provide any needed modifications to the building structure.
2. Kitchen Equipment Contractor shall deliver the Exhaust & MUA Fans and roof curbs to the General Contractor at the jobsite. Installation of the roof curbs and fans are by the General Contractor including any cranes, rigging, operators, etc.
3. U.L. listed, NSF approved, incandescent light fixtures equally spaced per section, pre-wired to common junction box. (1) One set of bulbs furnished and installed by K.E.C.
4. Stainless steel closure panels from top of hood to finished ceiling by K.E.C. (K.E.C. to verify height)
5. Surface fire protection system nozzles and piping to be installed at factory when fabricated with all exposed pipes and fittings in chrome plating or stainless steel.
6. Hood to have stainless steel hanger brackets welded to top of hood sections as required.
7. Full length make up air plenum along front of hood.
8. Provide Air Conditioned & Heated MUA Fan to provide tempered make up air.
9. All ductwork to be furnished and installed in accordance with all codes & regulations by the Mechanical Contractor and is not in the Kitchen Equipment Contract.
10. See Sheets QK-500 through QK-509 of the Contract Food Service Drawings.
11. Provide manufacturers shop drawings for review and approval.

ITEM # 85                      FIRE SUPPRESSION SYSTEM

Quantity:                      One (1)  
Manufacturer:                Captive-Aire or equal as approved by the Professional  
Model:                         TANK

One (1) Model TANK Ansul Fire Suppression System;

1. Surface nozzles, hood and duct protection nozzles to be in Ventilator, Item# 84.
2. Manual pull station and micro switch with one set of normally open and one set of normally closed contact points.
3. All exposed piping, fittings, control center and storage tanks to be chrome plated or stainless steel.
4. Six month and twelve month inspections, servicing, and replacement of components as per NFPA-96 latest edition.
5. All components and labor necessary for a complete system in accordance with NFPA-96 latest edition, OSHA, and all applicable codes.
6. System shall include One (1) gas solenoid valve(electric or mechanical as required) which shall be installed per local codes by Plumbing Contractor and interwired by Electrical Contractor if applicable. If a second gas valve is required by Codes, this is to be included in the Kitchen Equipment Contract.
7. Final installation and final testing by factory authorized Ansul agency.
8. This Authorized and Certified Fire Suppression System Contractor shall provide and install all electrical control interlocks required per NFPA 17A, NFPA 96 and all local codes, standards and regulations associated with fire suppression system installation. Wiring shall include necessary control interlocks from fire system micro switch to; exhaust and make up air fan motor control panel(s), electrical gas solenoid By Pass valve(s), commercial building fire alarm system, electrical disconnects and or shunt trip breaker controls as required per local jurisdiction having authority.
9. Electrical Division 16 to provide and install necessary shunt trip breakers or disconnects, fire alarm system modules, devises and or programming, and all required power circuitry associated with cooking equipment and fan units.

- A. A pre-engineered, fixed pipe, automatic wet chemical agent fire suppression system for protection of all hazard areas associated with cooking operations, including exhaust hoods, plenums, ductwork, and cooking appliances.
- B. Exhaust hood fire system components to be factory installed.
- C. Cylinder and Valve Assembly
  - a. The cylinders shall have a tin-nickel alloy plated brass valve with pressure gauge.
  - b. Wet chemical agent shall be contained in one or more stored pressure DOT/TC rated steel cylinder and valve assemblies.
  - c. Each cylinder is factory-filled with liquid fire suppressant and pressurized to 200 PSIGat 70°F.
- D. Distribution Nozzles
  - a. Nozzles shall be located to protect the exhaust ducts, plenums, and all cooking appliances requiring protection.
  - b. All nozzles shall be equipped with a metal blow off cap. The cap prevents contamination from entering the pipe network and is designed to pop-off upon system discharge, allowing agent to flow to the protected hazard area.
  - c. All nozzles shall incorporate a stamped part number to easily identify nozzle type.
- E. Distribution System
  - a. The distribution system shall consist of Copper, Schedule 40 black iron, chrome-plated or stainless-steel pipe and fittings. All exposed piping and fittings must be chrome-plated or stainless steel.
  - b. Fittings shall be minimum class 150. Galvanized fittings shall not be used.
- F. Suppression System
  - a. The system control equipment shall be capable of all functions associated with automatically and manually discharging the wet chemical agent from all cylinder and

- valve assemblies, including automatic shutdown of the heat source or fuel and electrical power to all protected areas upon system discharge.
- b. Liquid Fire Suppressant shall be Aqueous Potassium Carbonate (APC).
- c. All mechanical components of the actuator kit shall be enclosed.
- d. The actuator kit shall be capable of automatic or manual activation means.
- e. Supervisory Pressure Switch added to monitor operating system pressure.
- f. For manual activation, an electrically operated manual release shall be used to actuate the system manually.
- g. For automatic activation, the system will be activated by a Firestat (heat) detector.
- h. Electrical Division to provide shunt trip breakers at main power panel, or disconnects, as designated by the Electrical Engineer; interconnection provided at hood control panel for the signal to shut down all electricity in and under the exhaust hood. Shunt trips/disconnects to accomplish shut off of electricity in the event of fire system activation by others.
- i. Printed circuit board with microprocessor-based controller that provides all the necessary monitoring, timing, and supervision functions required for the reliable operation of the fire system.
- j. Independent supervised loops incorporate redundancy and fault detection.
- k. Real-time cloud-based monitoring connection provided with system by ownership.
- l. Primary power supply, with battery backup for power loss.
- m. All wiring must be in accordance to NFPA 70 and the Authority Having Jurisdiction (AHJ).
- n. Electric gas valve provided for equipment below exhaust hood. Coordinate size and installation with Plumbing Division.
- o. All wiring is to be in accordance with the applicable manufacturer's instructions for the fire alarm control panel, gas shut-off valve, manual reset relay, and contractor supplied shut-off devices.

ITEM # 86                      KETTLE, GAS, TILTING

Quantity:                      One (1)  
 Manufacturer:                Vulcan or equal as approved by the Professional  
 Model:                         K40GLT

One (1) Model K40GLT Tilting Kettle, Gas, 40-gallon true working capacity, 2/3 jacketed, 316 series stainless steel liner with ellipsoidal bottom, manual tilt, faucet bracket on tilting console, stainless steel construction, tri-leg base, 100,000 BTU  
 One (1) 1 year limited parts & labor warranty, standard  
 One (1) Natural gas (specify elevation if over 2,000 ft.)  
 One (1) 110-120v/50/60/1-ph, 5.0amps, cord, standard  
 One (1) Motorized Power Tilt  
 One (1) NOTE: This unit includes: embossed gallon/liter markings, 316 stainless steel liner & heavy bar rim standard  
 One (1) Model CATCH CAN Catch can with bail handle & 4' drain hose for DOV  
 One (1) Model CLEANUP KIT Clean-up Kit, includes draw-off brush, clean-up brush with 36" handle & paddle scraper with 40" handle  
 One (1) Model SSTWHIP 48 Stainless steel whip, 48"  
 One (1) Model SGLTS 18NZLJ SINGLE Pantry Deck Mount Faucet, 18" double jointed swivel spout, includes 4" & 12" riser, NSF & Lead Reduction Compliant (Note: water connection required)

One (1) Model 3/4QD HOSE-4 3/4" x 4' long gas flex hose & quick disconnect with restraining device

ITEM # 87 FLOOR TROUGH

Quantity: One (1)  
Manufacturer: IMC/Teddy or equal as approved by the Professional  
Model: ASFT-2436-SG

One (1) Model ASFT-2436-SG ASFT Anti-Spill Floor Trough, 36"W x 24"D, 6" deep receptacle, (1) 4" OD tailpiece, stainless steel beehive strainer, 14/304 stainless steel, brushed satin finish, (SG) subway grating, NSF, Made in USA

ITEM # 88 TILTING SKILLET BRAISING PAN, GAS

Quantity: One (1)  
Manufacturer: Vulcan or equal as approved by the Professional  
Model: VG40

One (1) Model VG40 Braising Pan, Gas, 40-gallon capacity, 46" wide open base, manual tilt, 9" deep stainless steel pan with gallon markings, pouring lip & removable strainer, spring assist cover with drip edge, pan holder, solid state control, includes L faucet bracket, electric ignition, 12" stainless steel legs with adjustable flanged feet, 120,000 BTU, CSA Flame, CSA Star, UL EPH Classified

One (1) 1 year limited parts & labor warranty, standard

One (1) Natural gas (specify elevation if over 2,000 ft.)

One (1) NOTE: Elevation kits are field installed

One (1) 120v/60/1-ph, 9.0 amps, cord & plug, standard

One (1) Model SGLTS 12NZL SINGLE Pantry Deck-Mount Faucet, 12" swivel spout, includes 4" & 12" riser, NSF & Lead Reduction Compliant (Note: water connection required)

One (1) Model 20X4 DRNPAN Drain pan & hose assembly

One (1) Model 3/4QD HOSE-4 3/4" x 4' long gas flex hose & quick disconnect with restraining device

ITEM # 89 FLOOR TROUGH

Quantity: One (1)  
Manufacturer: IMC/Teddy or equal as approved by the Professional  
Model: ASFT-2424-SG

One (1) Model ASFT-2424-SG ASFT Anti-Spill Floor Trough, 24"W x 24"D, 6" deep receptacle, (1) 4" OD tailpiece, stainless steel beehive strainer, 14/304 stainless steel, brushed satin finish, (SG) subway grating, NSF, Made in USA

ITEM # 90 CONVECTION STEAMER, GAS

Quantity: One (1)  
Manufacturer: Vulcan or equal as approved by the Professional  
Model: C24GA10

One (1) Model C24GA10 Convection Steamer, Gas, 2 compartments on 24" cabinet base, (10)12" x 20" x 2-1/2" deep total pan capacity, high output stainless steel steam generator with



Timed Smart Drain & PowerFlush, staged water fill, professional controls with 60 minute timer, buzzer for each compartment, & constant steam feature, split water line, stainless steel interior, exterior, frame & flanged feet, electric ignition, 125,000 BTU, CSA Flame, CSA Star, UL EPH Classified

One (1) 1 year limited parts & labor warranty, standard

One (1) Natural gas (specify elevation if over 2,000 ft.)

One (1) Model 3/4QD HOSE-4 3/4" x 4' long gas flex hose & quick disconnect with restraining device

One (1) 120v/60/1-ph with ground, 300w, 2.0 amps, cord & plug, standard

ITEM # 91                      CONVECTION OVEN, GAS

Quantity:                      One (1)

Manufacturer:                Blodgett or equal as approved by the Professional

Model:                         ZEPH-200-G DBL

One (1) Model ZEPH-200-G DBL Zephaire Convection Oven, gas, double-deck, bakery depth, capacity (5) 18" x 26" pans per compartment, (SSI-M) solid state infinite controls with 60 min. manual timer, two speed fan, flue connector, dependent glass doors, interior light, stainless steel front, sides and top, 6" stainless steel legs, 120,000 BTU, ETL, CE, NSF

One (1) 2 year parts, 2 year labor and 1 additional year door warranty (parts only), standard

One (1) Natural gas

Two (2) 115v/60/1-ph, 6.0 amps, 2-wire with ground, cord & plug, 1/2 hp (per deck), standard

One (1) Model SSI-D Top Oven: Solid State infinite with digital timer, standard

One (1) Model SSI-D Bottom Oven: Solid State infinite with digital timer, standard

One (1) Draft diverter, stainless steel, standard

One (1) 6" plate casters (set)

One (1) NOTE: DO NOT deduct cost of standard legs

One (1) 48" flexible gas hose with quick disconnect & restraining device

ITEM # 92                      COMBI OVEN, GAS

Quantity:                      One (1)

Manufacturer:                RATIONAL or equal as approved by the Professional

Model:                         ICC 20-FULL NG 208/240V 1 PH (LM200GG)

One (1) Model ICC 20-FULL NG 208/240V 1 PH (LM200GG) (CG2GRRRA.0000280 - NG - 208/240V) iCombi Classic® 20-Full Size Combi Oven, natural gas, (20) 18" x 26" sheet pan or (40) 12" x 20" steam pan or (20) 2/1 GN pan capacity, mobile oven rack & (10) stainless steel grids included, digital color display screen with push button control, (3) manual operating modes: steam, convection & combination, temperature range 85° to 572°F, (100) program slots, core temperature probe, retractable hand shower, 5-speed fan, (4) automatic cleaning programs, integrated care system, Ethernet interface, includes (1) bucket of Active Green Cleaner & (1) bucket of Care Tabs, 305,500 BTU, 208/240v/60/1-ph, 2.2 kW, 15 Amp Breaker, 6 ft. cord, IPX5, cCSAus, NSF

One (1) NOTE: All discounts subject to approval by manufacturer

One (1) 2 years parts and labor, 5 years steam generator warranty

One (1) Model CAP Chef Assistance Program, a RATIONAL certified Chef conducts 4 hours/location specialized application training with personnel, no charge

One (1) Model 1900.1154US Water Filtration Single Cartridge System, for any iVario, single Combi model, or XS or half-size Combi-Duos, includes: (1) single head with pressure gauge, R95H filter & filter installation kit

One (1) NOTE: The RATIONAL Water Filtration Systems helps provide consistent high quality water to your RATIONAL cooking systems. The patented carbon block technology reduces the effects of sediment, chloramines and chlorine while providing the required flow rates

One (1) Model 60.76.318 External Core Temperature Probe, USB connection, 20-half and full size

One (1) Model 60.22.440 Mobile Oven Rack, type 20-full size Pro/Classic, (12 L-rails) 24" x 20" sheet pan capacity, (24) 4" hotel pan capacity, 4-3/8" spacing, retractable handle, (Grids Shelves not needed)

ITEM # 93 STAINLESS STEEL WALL PANELS UNDER HOOD

Quantity: One (1)  
Manufacturer: Custom or equal as approved by the Professional  
Model: CUSTOM

One (1) Model CUSTOM Provide Stainless Steel Wall Cladding behind Exhaust Hood from floor tile base to up behind hood, approx. 21'-0" long. To be furnished and installed by the Kitchen Equipment Contractor. Provide all cut-outs as required for utilities with s/s escutcheons plates around any plumbing or gas lines. Provide outlet cut-outs sized so that outlet cover plates cover the cut-outs.

Provide shop drawings for review and approvals.

ITEM # 94 SPARE NO. <Spare No.>

ITEM # 95 WORK TABLE, STAINLESS STEEL TOP <By Owner>

Quantity: One (1)  
Manufacturer: Eagle Group or equal as approved by the Professional  
Model: T3696SEM

One (1) Model T3696SEM Spec-Master® Marine Series Work Table, 96"W x 36"D, 14/300 series stainless steel top, box marine edge on all sides, adjustable 18/300 series stainless steel undershelf with marine edge, Uni-Lok® gusset system, (6) stainless steel legs & adjustable bullet feet, NSF

One (1) Model TM96APR Pot Rack, table mount, 88"W x 20"D, triple-bar design with tubular table supports, constructed of 3/16" x 2" aluminum flat bar, includes (24) double-pronged pot hooks, for 96"W table, NSF

One (1) Model 502946 Drawer Assembly, 20" x 20" x 5", 430 type stainless steel housing & frame, removable drawer pan, NSF approved removable slides, hemmed safety pull handle

One (1) Model 300692 Bullet Feet, stainless steel, each

ITEM # 96 WORK TABLE, STAINLESS STEEL TOP

Quantity: One (1)  
Manufacturer: Eagle Group or equal as approved by the Professional  
Model: T3696SEM

One (1) Model T3696SEM Spec-Master® Marine Series Work Table, 96"W x 36"D, 14/300 series stainless steel top, box marine edge on all sides, adjustable 18/300 series stainless steel undershelf with marine edge, Uni-Lok® gusset system, (6) stainless steel legs & adjustable bullet feet, NSF

One (1) Model TM96APR Pot Rack, table mount, 88"W x 20"D, triple-bar design with tubular table supports, constructed of 3/16" x 2" aluminum flat bar, includes (24) double-pronged pot hooks, for 96"W table, NSF

One (1) Model E23 Sink, 16" x 20" x 14" bowl, for 30"W tables, complete with faucet & basket drain (specify location)

One (1) Model 300721 Lever Handle Drain, 2" IPS connection

One (1) Model 300692 Bullet Feet, stainless steel, each

ITEM # 97                      DECK MOUNT FAUCET

Quantity:                      One (1)

Manufacturer:                T&S Brass or equal as approved by the Professional

Model:                         B-1123

One (1) Model B-1123 Faucet, 12" swing nozzle, deck mounted, quarter-turn Eterna cartridges, lever handles, low lead, ADA Compliant

ITEM # 98                      WORK TABLE, STAINLESS STEEL TOP   <By Owner>

Quantity:                      One (1)

Manufacturer:                Eagle Group or equal as approved by the Professional

Model:                         T3696SEM

One (1) Model T3696SEM Spec-Master® Marine Series Work Table, 96"W x 36"D, 14/300 series stainless steel top, box marine edge on all sides, adjustable 18/300 series stainless steel undershelf with marine edge, Uni-Lok® gusset system, (6) stainless steel legs & adjustable bullet feet, NSF

Two (2) Model 502946 Drawer Assembly, 20" x 20" x 5", 430 type stainless steel housing & frame, removable drawer pan, NSF approved removable slides, hemmed safety pull handle

One (1) Model CA6-SB Table Casters, set of (6), 4" diameter, (3) swivel & (3) swivel/brake, 115 lbs. capacity per caster, zinc with resilient tread, NSF

ITEM # 99                      MOBILE REFRIGERATOR CABINET   <By Owner>

Quantity:                      Eight (8)

Manufacturer:                Metro or equal as approved by the Professional

Model:                         C5R9-SB

Eight (8) Model C5R9-SB C5™ R-Series Refrigeration Armour™ heavy-duty insulated mobile refrigerator, full height, adjustable bottom load slides 3.3" OC (adjustable on 1.65" increments), all-in-one refrigeration cassette with R134a refrigerant & automatic defrost (13) 18" x 26" or (26) 12" x 20" x 2-1/2" pan capacity, 304 stainless steel, foamed-in-place polyurethane insulation, operating temperature range 33°F to 40°F (factory pre-set at 35°F), 6" casters, 120V/60/1, 5.0 amps, NEMA 5-15P, cULus, NSF

ITEM # 100                     MOBILE HEATED CABINET   <By Owner>

Quantity:                      Eight (8)

Manufacturer:                Metro or equal as approved by the Professional

Model:                         TC90S

Eight (8) Model TC90S Half-Height Heated Cabinet, Reach-in, One-Section, stainless steel interior, aluminum exterior, standard depth cabinet, narrow full-height doors, with exterior dial-type thermometer, without bumper, pan capacity (9) 12-3/4 x 20-3/4, 120v/60/1-ph, 950 watts, NEMA 5-15P, cULus, NSF

ITEM # 101                    ICE MAKER, CUBE-STYLE

Quantity:                    One (1)  
Manufacturer:                Hoshizaki or equal as approved by the Professional  
Model:                        KM-660MAJ

One (1) Model KM-660MAJ Ice Maker, Cube-Style, 22"W, air-cooled, self-contained condenser, production capacity up to 665 lb/24 hours at 70°/50° (617 lb AHRI certified at 90°/70°), stainless steel finish, crescent cube Style, R-404A refrigerant, 115v/60/1-ph, 15.2 amps, NSF, UL  
One (1) Warranty: 3-Year parts & labor on entire machine  
One (1) Warranty: 5-Year parts & labor on evaporator  
One (1) Warranty: 5-Year parts on compressor & air-cooled condenser  
One (1) Model B-900SF Ice Bin, 52"W, top-hinged front-opening door, 900-lb ice storage capacity, for top-mounted ice makers, stainless steel exterior, painted legs included, protected with H-GUARD Plus Antimicrobial Agent, ETL, ETL-Sanitation  
One (1) Warranty: 3-Year parts & labor for bin  
One (1) Model HS-2035 Top Kit, 22", ABS  
One (1) Model HS-2033 Top Kit, 8", ABS  
One (1) Model SP-5429 Bin Door Catch (purchase as a service part)  
One (1) Model LP-6 LEG Leg Package, (4) x 6" stainless steel legs

ITEM # 102                    WATER FILTRATION SYSTEM, FOR ICE MACHINES

Quantity:                    One (1)  
Manufacturer:                Everpure or equal as approved by the Professional  
Model:                        EV932421

One (1) Model EV932421 Insurice® Water Filtration System, Insurice® Single PF-i2000<sup>2</sup>, Single, (1) EC210 Prefilter, (1) i2000<sup>2</sup> Micro-Pure® II Precoat primary filtration cartridge, reduces chlorine, taste & odor, inhibits scale, outlet pressure gauge, flushing valve, 9,000 gallons, 1.67 gpm, 0.5 micron, 3/4" inlet, 3/8" outlet, NSF 42 & 53 (EV932421)

ITEM # 103                    ICE BIN INCLUDED WITH ITEM 101    <Included>

ITEM # 104                    FLOOR TROUGH

Quantity:                    One (1)  
Manufacturer:                IMC/Teddy or equal as approved by the Professional  
Model:                        CFT-1260-PFG

One (1) Model CFT-1260-PFG CFT Floor Trough, 60"W x 12"D, 4" deep receptacle, (1) 4" OD tailpiece, stainless steel beehive strainer, 16/304 stainless steel construction, brushed satin finish, (PFG) pultruded fiberglass grating, grey, NSF, Made in USA  
One (1) Model BSX Beehive strainer for box drain

ITEM # 105                    SPARE NO.    <Spare No.>

ITEM # 106                    SPARE NO.   <Spare No.>

ITEM # 107                    SPARE NO.   <Spare No.>

ITEM # 108                    HOSE REEL

Quantity:                    One (1)  
Manufacturer:                T&S Brass or equal as approved by the Professional  
Model:                        B-7212-U01WS2E

One (1) Model B-7212-U01WS2E Hose Reel Assembly, open, 3/8" x 15 ft. hose with high flow blue spray valve with swivel (EB-0107), 8" wall mount mixing faucet, quarter-turn Eterna compression cartridges with spring checks, lever handles with color coated indexes, (2) 1/2" NPT in-line check valves, continuous pressure vacuum breaker, 3/8" NPT x 36" flexible water hose connector with stainless steel quick disconnect, ratcheting system, multi-fit bracket & adjustable hose bumper, (2) 2-3/8" wall brackets, EasyInstall 16" & rigid 40" risers, stainless steel hose reel, polished chrome-plated brass faucet body, 1/2" NPT female inlets  
One (1) 1 year limited warranty, standard  
One (1) 1 year limited warranty for hose, standard  
One (1) 2 year limited warranty for hose reel, standard  
One (1) Model MV-2516-24 Water Gun, rear trigger, 5/16" orifice, without coupling, stainless steel, blue rubber cover

ITEM # 109                    SPARE NO.   <Spare No.>

ITEM # 110                    REACH-IN REFRIGERATOR   <By Owner>

Quantity:                    One (1)  
Manufacturer:                Continental Refrigerator or equal as approved by the Professional  
Model:                        D2REN

One (1) Model D2REN Designer Line Wide Refrigerator, reach-in, 57"W, two-section, self-contained refrigeration, aluminum exterior & interior, stainless steel front, standard depth cabinet, wide full-height stainless steel doors, cylinder locks, electronic control with digital display, hi-low alarm, unit comes standard with expansion valve, 6" stainless steel legs, R290 Hydrocarbon Refrigerant, 1/3 HP, cETLus, NSF, Made in USA, ENERGY STAR®  
One (1) Standard warranty (for the United States & Canada Only): 3 year parts and labor; additional 4 year compressor part  
One (1) 115v/60/1-ph, 6.9 amps, cord, NEMA 5-15P, standard  
One (1) Both doors hinged on left  
One (1) Model 50205-4 Casters, swivel, with brakes (4" diameter rubber tires) set of 4 (5" height)

ITEM # 111                    WORK TABLE, STAINLESS STEEL TOP

Quantity:                    One (1)  
Manufacturer:                Eagle Group or equal as approved by the Professional  
Model:                        T30108STEM-BS

One (1) Model T30108STEM-BS Spec-Master® Marine Series Work Table, 108"W x 30"D, 4-1/2"H backsplash, 14/300 series stainless steel top, box marine edge on front & sides, Uni-Lok®

gusset system, stainless steel crossrails on side & rear, (6) stainless steel legs & adjustable bullet feet, NSF

ITEM # 112                      SHELIVING, WALL MOUNTED

Quantity:                      One (1)  
Manufacturer:                Eagle Group or equal as approved by the Professional  
Model:                         WS1596-14/3

One (1) Model WS1596-14/3 Shelf, wall-mounted, 96"W x 12"D, rolled frontedge, 1-1/2"H up-turn on sides & rear, includes stainless steel mounting brackets stud welded to shelf, 14/304 stainless steel construction, NSF  
One (1) Change shelf width to 15", replace 12 in model number with 15

ITEM # 113                      SHELIVING, WITH METAL FRAME <By Owner>

Quantity:                      Five (5)  
Manufacturer:                Metro or equal as approved by the Professional  
Model:                         MQ2454G

Five (5) Model MQ2454G MetroMax® Q Shelf, 54"W x 24"D, removable open grid polymer shelf mats on an epoxy coated steel frame with quick adjust corner releases, (4) wedge connectors, Microban® antimicrobial product protection, 600 lb. capacity per shelf, NSF  
(THESE MAKE UP ONE (1) MOBILE SHELIVING UNIT WITH FIVE SHELVES EACH)  
Four (4) Model MX86UP Polymer trilobal post (compatible with MetroMax® i, MetroMax® 4, MetroMax® Q), 85-3/16"H, for use with stem casters, adjusts at 1" increments, corrosion proof all polymer construction with built in Microban® antimicrobial product protection  
Two (2) Model 5MPXGSA Stainless Steel Cart-Washable Stem Caster, swivel, flat polyurethane wheel tread, 300 lb. capacity. NSF listed(for use with all MetroMax posts & shelves)  
Two (2) Model 5MPBXGSA Stainless Steel Cart-Washable Stem Caster, brake, flat polyurethane wheel tread, 300 lb. capacity, NSF (for use with all MetroMax posts & shelves)

ITEM # 114                      BEVERAGE COUNTER

Quantity:                      One (1)  
Manufacturer:                Eagle Group or equal as approved by the Professional  
Model:                         BEV30144SEM-10BS/R

One (1) Model BEV30144SEM-10BS/R Spec-Master® Marine Series Beverage Counter, 144"W x 30"D, 14/304 stainless steel top, 10"H backsplash with NEMA 5-20R receptacle (120v/1-ph, 20A), box marine edge on front & sides, sink on right with deck mount faucet, urn trough on left with louvered insert & 1-1/2" drain, (4) hinged doors on front, 8" OC rack slides for (6) glass racks, Uni-Lok® gusset system, includes Z-clip wall mounting brakcet, stainless steel cabinet, legs, & adjustable bullet feet, NSF  
(PROVIDE CUTOUT/REINFORCEMENT FOR ITEM 118 - ICE/WATER STATION WHERE SHOWN ON PLAN)

ITEM # 115                      FAUCET INCLUDED WITH ITEM 114 <Included>

ITEM # 116 MILK DISPENSER <By Owner>

Quantity: One (1)  
Manufacturer: Silver King or equal as approved by the Professional  
Model: SKMAJ2-C4

One (1) Model SKMAJ2-C4 Majestic Series Milk Dispenser, refrigerated, double spring-loaded valve, 12 gallon capacity, (accommodates 3, 5, or 6 gallon bags), includes (2) platforms, (2) crates, stainless steel interior & exterior with galvanized bottom, bottom-mounted self-contained refrigeration, 134A, 1/10 HP, 115v/60/1-ph, 1.4 amps, cord & NEMA 5-15P, cETLus, ETL-Sanitation

One (1) 1 year parts & labor warranty, 5 year compressor (part only) warranty, 90 days replacement parts, standard

ITEM # 117 JUICE DISPENSER - NIKEC <By Owner>

ITEM # 118 ICE & WATER DISPENSER

Quantity: One (1)  
Manufacturer: Randell or equal as approved by the Professional  
Model: 9515

One (1) Model 9515 Drop-In Ice & Water Unit, 21-7/8"W x 15-1/2"D, 43 lb. insulated ice chest, stainless steel top & coved corner interior, removable stainless steel cover, glass filler with drain trough, Made in USA

One (1) Model DIFILPTI Pitcher Filler, in lieu of glass filler

One (1) Everpure Model EV927560 QL2 Water Filtration System, QL2-OCS<sup>2</sup>, Single, (1) OCS<sup>2</sup> Precoat primary filtration cartridge, reduces chlorine, taste and odor, (1) self-contained scale inhibitor feed, 1,500 gallons, 0.5 gpm, 0.5 micron, 3/8" inlet, 3/8" outlet, NSF 42 & 53 (EV927560)

ITEM # 119 TEA BREWER <By Owner>

ITEM # 120 COFFEE URN/BREWER <By Owner>

ITEM # 121 SPARE NO. <Spare No.>

ITEM # 122 SPARE NO. <Spare No.>

ITEM # 123 FLATWARE & TRAY CART <By Owner>

Quantity: One (1)  
Manufacturer: Low Temp Industries or equal as approved by the Professional  
Model: 36-RTE/RTS

One (1) Model 36-RTE/RTS SpecLine Tray Stand, step down, 36-3/8"W x 30"D x 36"H, 14ga stainless steel top, specify base, 5" casters all with brakes, UL, cUL, UL EPH

One (1) Molded fiberglass

One (1) Standard color

One (1) (LL) Silverware wells (4" cut-out complete with nylon cylinders)

- One (1) (AA) Line up lock
- One (1) 5" Casters (standard)

ITEM # 124                      HOT FOOD SERVING COUNTER / TABLE   <By Owner>

Quantity:                      One (1)  
 Manufacturer:                Low Temp Industries or equal as approved by the Professional  
 Model:                         84-EFS5-CPA

- One (1) Model 84-EFS5-CPA SpecLine Hot Food Serving Counter, 84-3/8"W x 30"D x 36"H, (5) 12" x 20" hot wells, wet & dry operation, individual digital controls, 14ga stainless steel top, specify base, rear storage openings, (6) 5" locking swivel casters, UL, cUL, UL EPH Classified
- One (1) 120v/60/1-ph, 31.3 amps, 3755 watts, NEMA 5-30P - Base unit voltage subject to change based on options
- One (1) Molded fiberglass
- One (1) Standard color
- One (1) (AA) Line up lock
- One (1) (A) Solid tray slide with (2) inverted "V" ridges on surface, stainless steel
- One (1) (GCG) Sloped front protector, glass clips, glass top shelf
- One (1) Tempered glass
- One (1) (U) Infrared heat lamp strip with lights
- One (1) (Y) Hinged door
- One (1) 5" Casters (standard)

ITEM # 125                      SERVING COUNTER, COLD FOOD   <By Owner>

Quantity:                      One (1)  
 Manufacturer:                Low Temp Industries or equal as approved by the Professional  
 Model:                         84-CFMA

- One (1) Model 84-CFMA SpecLine TempestAir Cold Serving Counter, 84-3/8"W x 30"D x 36"H, 14ga stainless steel top with (1) 64"W x 20"D x 9" deep stainless steel cold well, accommodates (5) full size 6" deep food pans, forced air refrigeration with (2) fans, specify base, rear storage opening, 5" casters all with brakes, 1/3 HP, UL, cUL, UL EPH
- One (1) 120v/60/1-ph, 8.5 amps, NEMA 5-15P - Base unit voltage subject to change based on options
- One (1) Molded fiberglass
- One (1) Standard color
- One (1) (AA) Line up lock
- One (1) (A) Solid tray slide with (2) inverted "V" ridges on surface, stainless steel
- One (1) (GCG) Sloped front protector, glass clips, glass top shelf
- One (1) Tempered glass
- One (1) (Y) Hinged door
- One (1) 5" Casters (standard)

ITEM # 126                      SERVING COUNTER, UTILITY   <By Owner>

Quantity:                      One (1)  
 Manufacturer:                Low Temp Industries or equal as approved by the Professional  
 Model:                         84-ST

- One (1) Model 84-ST SpecLine Solid Utility Food Table, 14ga stainless steel top, 84-3/8"W x 30"D x 36"H, specify base, rear storage openings, 5" casters all with brakes, UL, cUL, UL EPH



- One (1) Molded fiberglass
- One (1) Standard color
- One (1) (AA) Line up lock
- One (1) (A) Solid tray slide with (2) inverted "V" ridges on surface, stainless steel
- One (1) (GCG) Sloped front protector, glass clips, glass top shelf
- One (1) Tempered glass
- One (1) (Y) Hinged door
- One (1) 5" Casters (standard)

ITEM # 127                    SPARE NO.   <Spare No.>

ITEM # 128                    SPARE NO.   <Spare No.>

ITEM # 129                    MOBILE REFRIGERATOR CABINET   <By Owner>

Quantity:                    One (1)  
 Manufacturer:              Metro or equal as approved by the Professional  
 Model:                        C5R9-SB

One (1) Model C5R9-SB C5™ R-Series Refrigeration Armour™ heavy-duty insulated mobile refrigerator, full height, adjustable bottom load slides 3.3" OC (adjustable on 1.65" increments), all-in-one refrigeration cassette with R134a refrigerant & automatic defrost (13) 18" x 26" or (26) 12" x 20" x 2-1/2" pan capacity, 304 stainless steel, foamed-in-place polyurethane insulation, operating temperature range 33°F to 40°F (factory pre-set at 35°F), 6" casters, 120V/60/1, 5.0 amps, NEMA 5-15P, cULus, NSF

ITEM # 130                    MOBILE HEATED CABINET   <By Owner>

Quantity:                    One (1)  
 Manufacturer:              Metro or equal as approved by the Professional  
 Model:                        TC90S

One (1) Model TC90S Half-Height Heated Cabinet, Reach-in, One-Section, stainless steel interior, aluminum exterior, standard depth cabinet, narrow full-height doors, with exterior dial-type thermometer, without bumper, pan capacity (9) 12-3/4 x 20-3/4, 120v/60/1-ph, 950 watts, NEMA 5-15P, cULus, NSF

ITEM # 131-199              SPARE NO.   <Spare No.>

ITEM # 200                    WIRE SHELVING   <By Owner>

Quantity:                    Sixty (60)  
 Manufacturer:              Metro or equal as approved by the Professional  
 Model:                        1448NK3

Sixty (60) Model 1448NK3 Super Erecta® Shelf, wire, 48"W x 14"D, Metroseal™ Green epoxy-coated corrosion-resistant finish with Microban® antimicrobial protection, plastic split sleeves are included in each carton, NSF  
 (THESE MAKE UP TWELVE (12) SHELVING UNITS WITH FIVE SHELVES EACH)

Fourty-Eight (48) Model 86PK3 Super Erecta® SiteSelect™ Post, 86-1/2"H, adjustable leveling bolt, posts are grooved at 1" increments & numbered at 2" increments, double grooved every 8", Metroseal 3 Green epoxy coated corrosion-resistant finish with Microban® antimicrobial protection

Fourty (40) Model 2436NK3 Super Erecta® Shelf, wire, 36"W x 24"D, Metroseal™ Green epoxy-coated corrosion-resistant finish with Microban® antimicrobial protection, plastic split sleeves are included in each carton, NSF

(THESE MAKE UP EIGHT (8) SHELVING UNITS WITH FIVE SHELVES EACH)

Thirty-Two (32) Model 86PK3 Super Erecta® SiteSelect™ Post, 86-1/2"H, adjustable leveling bolt, posts are grooved at 1" increments & numbered at 2" increments, double grooved every 8", Metroseal 3 Green epoxy coated corrosion-resistant finish with Microban® antimicrobial protection

ITEM # 201                      DISH CART / DOLLY   <By Owner>

Quantity:                      Four (4)  
Manufacturer:                Metro or equal as approved by the Professional  
Model:                         PCD11A

Four (4) Model PCD11A Poker Chip Dish Dolly, 26-5/8"W x 26-5/8"D x 31-15/16"H, adjustable, dish size 4-1/4" to 11-3/4", removable dividers & towers, two-handed access, recessed handles, 5"Dia. swivel casters with neoprene wheels (2 with brakes), chip-resistant polymer shell with Microban® antimicrobial protection, aesthetic blue, vinyl dust/water splash cover, NSF

ITEM # 202.1                 REACH-IN FREEZER   <By Owner>

Quantity:                      Two (2)  
Manufacturer:                Continental Refrigerator or equal as approved by the Professional  
Model:                         1FESNHD

Two (2) Model 1FESNHD Extra-Wide Freezer, reach-in, 28-1/2"W, one-section, self-contained refrigeration, stainless steel front, aluminum interior & ends, shallow depth, half-height solid doors, cylinder locks, electronic control with digital display, unit can be adjusted to operate as low as -10°F, hi-low alarm, unit comes standard with expansion valve, electric condensate evaporator, R290 Hydrocarbon refrigerant, 1/2 HP, cETLus, NSF, Made in USA

Two (2) Standard warranty (for the United States & Canada Only): 3 year parts and labor; additional 4 year compressor part

Two (2) 115v/60/1-ph, 7.6 amps, cord, NEMA 5-15P, standard

Two (2) Door hinged on right, standard

Two (2) 5" Casters, standard

ITEM # 202.2                 REACH-IN FREEZER   <By Owner>

Quantity:                      Two (2)  
Manufacturer:                Continental Refrigerator or equal as approved by the Professional  
Model:                         1FESNHD

Two (2) Model 1FESNHD Extra-Wide Freezer, reach-in, 28-1/2"W, one-section, self-contained refrigeration, stainless steel front, aluminum interior & ends, shallow depth, half-height solid doors, cylinder locks, electronic control with digital display, unit can be adjusted to operate as low as -10°F, hi-low alarm, unit comes standard with expansion valve, electric condensate evaporator, R290 Hydrocarbon refrigerant, 1/2 HP, cETLus, NSF, Made in USA

Two (2) Standard warranty (for the United States & Canada Only): 3 year parts and labor; additional 4 year compressor part  
Two (2) 115v/60/1-ph, 7.6 amps, cord, NEMA 5-15P, standard  
Two (2) Door hinged on left  
Two (2) 5" Casters, standard

ITEM # 203 MOBILE REFRIGERATOR CABINET <By Owner>

Quantity: Four (4)  
Manufacturer: Metro or equal as approved by the Professional  
Model: C5R9-SB

Four (4) Model C5R9-SB C5™ R-Series Refrigeration Armour™ heavy-duty insulated mobile refrigerator, full height, adjustable bottom load slides 3.3" OC (adjustable on 1.65" increments), all-in-one refrigeration cassette with R134a refrigerant & automatic defrost (13) 18" x 26" or (26) 12" x 20" x 2-1/2" pan capacity, 304 stainless steel, foamed-in-place polyurethane insulation, operating temperature range 33°F to 40°F (factory pre-set at 35°F), 6" casters, 120V/60/1, 5.0 amps, NEMA 5-15P, cULus, NSF

ITEM # 204 MOBILE HEATED CABINET <By Owner>

Quantity: Four (4)  
Manufacturer: Metro or equal as approved by the Professional  
Model: TC90S

Four (4) Model TC90S Half-Height Heated Cabinet, Reach-in, One-Section, stainless steel interior, aluminum exterior, standard depth cabinet, narrow full-height doors, with exterior dial-type thermometer, without bumper, pan capacity (9) 12-3/4 x 20-3/4, 120v/60/1-ph, 950 watts, NEMA 5-15P, cULus, NSF

ITEM # 205 HAND SINK

Quantity: Six (6)  
Manufacturer: Eagle Group or equal as approved by the Professional  
Model: HSA-10-FKP

Six (6) Model HSA-10-FKP Hand Sink, wall mount, 13-1/2" wide x 9-3/4" front-to-back x 6-3/4" deep bowl, 304 stainless steel construction, splash mount gooseneck spout, single knee pedal, skirt, basket drain, deep-drawn seamless design-positive drain, inverted "V" edge, NSF  
Six (6) Model -MG MicroGard™ antimicrobial finish on bowl only- add suffix "-MG" to end of hand sink model number  
Six (6) Model -LRS Left & right side splashes

ITEM # 206 SOAP & TOWEL DISPENSERS - NIKEC <By Owner>

ITEM # 207 HOT FOOD SERVING COUNTER / TABLE <By Owner>

Quantity: Four (4)  
Manufacturer: Eagle Group or equal as approved by the Professional  
Model: SPHT5CB-208

Four (4) Model SPHT5CB-208 Spec-Master® Sealed Well Hot Food Table, electric, 22 gauge stainless steel sliding doors with recessed handle, 79"W x 32-1/4"D x 35-1/2"H, wet or dry operation, (5) 12" x 20" stainless steel sealed wells, individual infinite controls, drain manifold with valve, includes removable poly cutting board, stainless steel dish shelf, 430 stainless steel construction, end panel push bar on right, 4" swivel casters (2 with brakes), 3750 watts, 208v/60/1-ph, 17.2 amps, NEMA 6-30P, NSF, cULus

Four (4) Model 421505 Flex-Master® Overshelf, for 5-well unit, 79"W x 15"D, posts sold separately, (require (2) pairs of posts) NSF

ITEM # 208                      SPARE NO.    <Spare No.>

ITEM # 209                      WIRE SHELVING    <By Owner>

Quantity:                      (10)  
Manufacturer:                Metro or equal as approved by the Professional  
Model:                         2454NK3

(10) Model 2454NK3 Super Erecta® Shelf, wire, 54"W x 24"D, Metroseal™ Green epoxy-coated corrosion-resistant finish with Microban® antimicrobial protection, plastic split sleeves are included in each carton, NSF

(THESE MAKE UP TWO (2) SHELVING UNITS WITH FIVE SHELVES EACH)

Eight (8) Model 86PK3 Super Erecta® SiteSelect™ Post, 86-1/2"H, adjustable leveling bolt, posts are grooved at 1" increments & numbered at 2" increments, double grooved every 8", Metroseal 3 Green epoxy coated corrosion-resistant finish with Microban® antimicrobial protection

ITEM # 210.1                    SOILED DISHTABLE

Quantity:                      One (1)  
Manufacturer:                Eagle Group or equal as approved by the Professional  
Model:                         UDT-4L-14/3

One (1) Model UDT-4L-14/3 Spec-Master® Undercounter Dishtable, dishwasher on left, 48"W x 27-1/2"D x 43-1/2"H overall, 14/304 stainless steel top, 20" x 20" x 5" pre-rinse sink includes basket drain with removable crumb cup, 8"H backsplash, single deck mount faucet hole for pre-rinse, raised rolled rims on front & sides, accommodates 24" (front-to-back) undercounter dishwasher, stainless steel legs & crossrails with adjustable metal feet, adjustable metal feet, NSF

One (1) Model 606434 Pre-rinse Basket, 17-1/2"W x 19-1/2"L x 2"H, with slide bar, for dishtables, 304 type stainless steel

One (1) Model 606641 Slanted Rack Shelf, solid, wall mount, 21"W x 19-3/4"D x 21-3/8"H, stainless steel wall brackets, stainless steel drip tube (right side), 16/304 stainless steel construction

ITEM # 210.2                    SOILED DISHTABLE

Quantity:                      One (1)  
Manufacturer:                Eagle Group or equal as approved by the Professional  
Model:                         UDT-4R-14/3

One (1) Model UDT-4R-14/3 Spec-Master® Soiled Dishtable, undercounter, dishwasher on right, 48"W x 27-1/2"D x 43-1/2"H overall, 14/304 stainless steel top, 20" x 20" x 5" pre-rinse sink

includes basket drain with removable crumb cup, 8"H backsplash, single deck mount faucet hole for pre-rinse, raised rolled rims on front & sides, accommodates 24" (front-to-back) undercounter dishwasher, stainless steel legs & crossrails with adjustable metal feet, adjustable metal feet, NSF

One (1) Model 606434 Pre-rinse Basket, 17-1/2"W x 19-1/2"L x 2"H, with slide bar, for dishtables, 304 type stainless steel

One (1) Model 606641 Slanted Rack Shelf, solid, wall mount, 21"W x 19-3/4"D x 21-3/8"H, stainless steel wall brackets, stainless steel drip tube (right side), 16/304 stainless steel construction

ITEM # 211                    PRE-RINSE FAUCET ASSEMBLY

Quantity:                    Two (2)  
Manufacturer:                T&S Brass or equal as approved by the Professional  
Model:                        B-0113-BR

Two (2) Model B-0113-BR EasyInstall Pre-Rinse Unit, spring action gooseneck & hole base faucet, 1.15 GPM spray valve (B-0107), 44" flexible stainless steel hose, 24" riser, 18" flexible supply lines, 6" wall bracket, quarter-turn Eterna cartridges, low lead, 2019 DOE PRSV - Class II

ITEM # 212                    DISHWASHER, UNDERCOUNTER

Quantity:                    Two (2)  
Manufacturer:                Hobart or equal as approved by the Professional  
Model:                        CUH-1

Two (2) Model CUH-1 Centerline Dishwasher, undercounter, 22 11/16"W x 24"D x 32 5/16"H, high temperature sanitizing, (24) racks/hr, fresh water rinse, .84 gal/rack, delime notification and cycle, service diagnostics with error notifications, soft start, detergent & rinse aid pumps, 208-240v/60/1-ph, 24.2-27.5 amps, ships with (1) peg rack and (1) combo rack, cULus, NSF (Pricing options available, please contact your local rep for more information) (NET price shown)

Two (2) Standard warranty - 1-Year parts, labor & travel time during normal working hours within the USA

Two (2) Model PWRCORD-30A240V1P Power Cord Kit, 208-240v/60/1-ph, NEMA 6-30P plug included (net)

Four (4) Model DISHRAK-PEG20 Peg rack

Four (4) Model DISHRAK-COM20 Combination rack

ITEM # 213                    (2) DISH SORT WALL SHELF INCLUDED WITH ITEM 210    <Included>

ITEM # 214                    RACK DOLLY    <By Owner>

Quantity:                    Two (2)  
Manufacturer:                Metro or equal as approved by the Professional  
Model:                        DH2020N

Two (2) Model DH2020N Dish Rack Dolly, platform design, single stack, designed for 20" x 20" racks, tubular steel handle, 5" Heavy duty, non-marking, resilient tread swivel casters, bumper corners, all aluminum construction, with handle

ITEM # 215                    SPARE NO.    <Spare No.>

ITEM # 216 SPARE NO. <Spare No.>

ITEM # 217 MILLWORK BEVERAGE COUNTER - NIKEC <By G/C>

ITEM # 218 DROP-IN DUMP SINK

Quantity: Four (4)  
Manufacturer: BK Resources or equal as approved by the Professional  
Model: DDI-1014524S-P-G

Four (4) Model DDI-1014524S-P-G Deep Drawn Drop-In Sink, one compartment, 12-5/8"W x 18-1/2"D x 10-1/2"H overall size, (1) 10" wide x 14" front-to-back x 5" deep compartment, includes deck mount faucet (BKD-5G-G), 6"H splashes on sides & rear, includes basket drain (BKDR-4), 18/304 stainless steel construction, lead free, NSF

ITEM # 219 (4) COFFEE BREWERS - NIKEC <By Vendor>

ITEM # 220 (4) MILK COOLERS - NIKEC <By Vendor>

ITEM # 221 (4) JUICE DISPENSERS - NIKEC <By Vendor>

ITEM # 222 NUGGET ICE MAKER/WATER & ICE DISPENSER

Quantity: Four (4)  
Manufacturer: Manitowoc or equal as approved by the Professional  
Model: RNK0320AZ

Four (4) Model RNK0320AZ Ice Maker, nugget-style, air-cooled, self-contained condenser, 22"W x 23-5/8"D x 26"H, production capacity up to 308 lb/24 hours at 70°/50° (236 lb AHRI certified at 90°/70°), bite size nugget, high-load stainless steel bearings, stainless steel finish, 1/2 HP, R-404A, ETL-Sanitation, cETLus

Four (4) Model WARRANTY-RF/RFS/RNS 3 year parts & labor (Machine), 5 parts & 3 years labor (Compressor), standard

Four (4) (-251) 230v/50/1-ph, CE

Four (4) Model AR-10000-P Arctic Pure® Plus Primary Water Filter Assembly, includes head, shroud, hardware, mounting assembly, & (1) filter cartridge, 15,000 gallon capacity, 0-600 lbs./ice per day

Four (4) Model WARRANTY-ARCPURE 3 year parts & labor warranty on cap, housing, hardware, & mounting assembly (does not refer to filter cartridge), standard

Four (4) Model S-150-2704811 Ice Dispenser with Water Valve, countertop, 23"W x 31-1/8"D x 34-7/8"H, 150 lb. ice storage capacity, Rocking Chute™ ice dispensing, lever activated, includes: lighted merchandiser with "ice" graphics, leg kit and drain kit, stainless steel exterior, cUL, UL, NSF (apply Multiplex discount to this item)

Four (4) 1 year parts & labor warranty, standard

Four (4) 120v/60/1-ph, standard

Four (4) Model SL26-020000245 Bin Adapter, required for 22" cuber or nugget ice machine on an S-150 ice dispenser (apply Multiplex discount to this item)

Four (4) NOTE: Agitator and ice level management kit required for use with nugget ice machines on S-Dispensers

Four (4) Model K00488 Dispenser Thermostat Kit, reduces ice machine overfill & condensation problems, for use with nugget machines mounted to soda dispensers

ITEM # 223                    DROP-IN HAND SINK

Quantity:                    Four (4)  
Manufacturer:                BK Resources or equal as approved by the Professional  
Model:                        DDI-1014524S-P-G

Four (4) Model DDI-1014524S-P-G Deep Drawn Drop-In Sink, one compartment, 12-5/8"W x 18-1/2"D x 10-1/2"H overall size, (1) 10" wide x 14" front-to-back x 5" deep compartment, includes deck mount faucet (BKD-5G-G), 6"H splashes on sides & rear, includes basket drain (BKDR-4), 18/304 stainless steel construction, lead free, NSF

ITEM # 224                    UNDERCOUNTER REFRIGERATOR   <By Owner>

Quantity:                    Four (4)  
Manufacturer:                Continental Refrigerator or equal as approved by the Professional  
Model:                        SW32N-U

Four (4) Model SW32N-U Undercounter Refrigerator, 32"W, 9.0 cu ft capacity, one-section, (1) field rehingeable door, stainless steel front, top & end panels, aluminum interior, 1-3/8" diameter plate casters, front breathing, rear-mounted self-contained refrigeration, R290 Hydrocarbon refrigerant, 1/5 hp, cETLus, Made in USA, ENERGY STAR®  
Four (4) Standard warranty (for the United States & Canada Only): 3 year parts and labor; additional 4 year compressor part  
Four (4) 115v/60/1-ph, 2.46 amps, cord, NEMA 5-15P, standard  
Four (4) Door hinged on right, standard  
Four (4) Cylinder lock (per door/drawer)

ITEM # 225                    RACK DOLLY   <By Owner>

Quantity:                    Eight (8)  
Manufacturer:                Metro or equal as approved by the Professional  
Model:                        DH2020N

Eight (8) Model DH2020N Dish Rack Dolly, platform design, single stack, designed for 20" x 20" racks, tubular steel handle, 5" Heavy duty, non-marking, resilient tread swivel casters, bumper corners, all aluminum construction, with handle

ITEM # 300                    WIRE SHELVING   <By Owner>

Quantity:                    Twenty (20)  
Manufacturer:                Metro or equal as approved by the Professional  
Model:                        1436NK3

Twenty (20) Model 1436NK3 Super Erecta® Shelf, wire, 36"W x 14"D, Metroseal™ Green epoxy-coated corrosion-resistant finish with Microban® antimicrobial protection, plastic split sleeves are included in each carton, NSF  
(THESE MAKE UP FOUR (4) SHELVING UNITS WITH FIVE SHELVES EACH)  
Sixteen (16) Model 86PK3 Super Erecta® SiteSelect™ Post, 86-1/2"H, adjustable leveling bolt, posts are grooved at 1" increments & numbered at 2" increments, double grooved every 8",

Metroseal 3 Green epoxy coated corrosion-resistant finish with Microban® antimicrobial protection  
 Sixty (60) Model 1448NK3 Super Erecta® Shelf, wire, 48"W x 14"D, Metroseal™ Green epoxy-coated corrosion-resistant finish with Microban® antimicrobial protection, plastic split sleeves are included in each carton, NSF  
 (THESE MAKE UP TWELVE (12) SHELVING UNITS WITH FIVE SHELVES EACH)  
 Forty-Eight (48) Model 86PK3 Super Erecta® SiteSelect™ Post, 86-1/2"H, adjustable leveling bolt, posts are grooved at 1" increments & numbered at 2" increments, double grooved every 8", Metroseal 3 Green epoxy coated corrosion-resistant finish with Microban® antimicrobial protection  
 Forty (40) Model 2436NK3 Super Erecta® Shelf, wire, 36"W x 24"D, Metroseal™ Green epoxy-coated corrosion-resistant finish with Microban® antimicrobial protection, plastic split sleeves are included in each carton, NSF  
 (THESE MAKE UP EIGHT (8) SHELVING UNITS WITH FIVE SHELVES EACH)  
 Thirty-Two (32) Model 86PK3 Super Erecta® SiteSelect™ Post, 86-1/2"H, adjustable leveling bolt, posts are grooved at 1" increments & numbered at 2" increments, double grooved every 8", Metroseal 3 Green epoxy coated corrosion-resistant finish with Microban® antimicrobial protection

ITEM # 301 RACK DOLLY <By Owner>

Quantity: Two (2)  
 Manufacturer: Metro or equal as approved by the Professional  
 Model: DH2020N

Two (2) Model DH2020N Dish Rack Dolly, platform design, single stack, designed for 20" x 20" racks, tubular steel handle, 5" Heavy duty, non-marking, resilient tread swivel casters, bumper corners, all aluminum construction, with handle

ITEM # 302.1 REACH-IN FREEZER <By Owner>

Quantity: Two (2)  
 Manufacturer: Continental Refrigerator or equal as approved by the Professional  
 Model: 1FESNHD

Two (2) Model 1FESNHD Extra-Wide Freezer, reach-in, 28-1/2"W, one-section, self-contained refrigeration, stainless steel front, aluminum interior & ends, shallow depth, half-height solid doors, cylinder locks, electronic control with digital display, unit can be adjusted to operate as low as -10°F, hi-low alarm, unit comes standard with expansion valve, electric condensate evaporator, R290 Hydrocarbon refrigerant, 1/2 HP, cETLus, NSF, Made in USA  
 Two (2) Standard warranty (for the United States & Canada Only): 3 year parts and labor; additional 4 year compressor part  
 Two (2) 115v/60/1-ph, 7.6 amps, cord, NEMA 5-15P, standard  
 Two (2) Door hinged on right, standard  
 Two (2) 5" Casters, standard

ITEM # 302.2 REACH-IN FREEZER <By Owner>

Quantity: Two (2)  
 Manufacturer: Continental Refrigerator or equal as approved by the Professional  
 Model: 1FESNHD



Two (2) Model 1FESNHD Extra-Wide Freezer, reach-in, 28-1/2"W, one-section, self-contained refrigeration, stainless steel front, aluminum interior & ends, shallow depth, half-height solid doors, cylinder locks, electronic control with digital display, unit can be adjusted to operate as low as -10°F, hi-low alarm, unit comes standard with expansion valve, electric condensate evaporator, R290 Hydrocarbon refrigerant, 1/2 HP, cETLus, NSF, Made in USA  
Two (2) Standard warranty (for the United States & Canada Only): 3 year parts and labor; additional 4 year compressor part  
Two (2) 115v/60/1-ph, 7.6 amps, cord, NEMA 5-15P, standard  
Two (2) Door hinged on left  
Two (2) 5" Casters, standard

ITEM # 303                    MOBILE REFRIGERATOR CABINET   <By Owner>

Quantity:                    Four (4)  
Manufacturer:               Metro or equal as approved by the Professional  
Model:                        C5R9-SB

Four (4) Model C5R9-SB C5™ R-Series Refrigeration Armour™ heavy-duty insulated mobile refrigerator, full height, adjustable bottom load slides 3.3" OC (adjustable on 1.65" increments), all-in-one refrigeration cassette with R134a refrigerant & automatic defrost (13) 18" x 26" or (26) 12" x 20" x 2-1/2" pan capacity, 304 stainless steel, foamed-in-place polyurethane insulation, operating temperature range 33°F to 40°F (factory pre-set at 35°F), 6" casters, 120V/60/1, 5.0 amps, NEMA 5-15P, cULus, NSF

ITEM # 304                    MOBILE HEATED CABINET   <By Owner>

Quantity:                    Four (4)  
Manufacturer:               Metro or equal as approved by the Professional  
Model:                        TC90S

Four (4) Model TC90S Half-Height Heated Cabinet, Reach-in, One-Section, stainless steel interior, aluminum exterior, standard depth cabinet, narrow full-height doors, with exterior dial-type thermometer, without bumper, pan capacity (9) 12-3/4 x 20-3/4, 120v/60/1-ph, 950 watts, NEMA 5-15P, cULus, NSF

ITEM # 305                    HAND SINK

Quantity:                    Six (6)  
Manufacturer:               Eagle Group or equal as approved by the Professional  
Model:                        HSA-10-FKP

Six (6) Model HSA-10-FKP Hand Sink, wall mount, 13-1/2" wide x 9-3/4" front-to-back x 6-3/4" deep bowl, 304 stainless steel construction, splash mount gooseneck spout, single knee pedal, skirt, basket drain, deep-drawn seamless design-positive drain, inverted "V" edge, NSF  
Six (6) Model -MG MicroGard™ antimicrobial finish on bowl only- add suffix "-MG" to end of hand sink model number  
Six (6) Model -LRS Left & right side splashes

ITEM # 306                    SOAP & TOWEL DISPENSERS   <By Owner>

ITEM # 307                   HOT FOOD SERVING COUNTER / TABLE   <By Owner>

Quantity:                   Four (4)  
Manufacturer:              Eagle Group or equal as approved by the Professional  
Model:                      SPHT5CB-208

Four (4) Model SPHT5CB-208 Spec-Master® Sealed Well Hot Food Table, electric, 22 gauge stainless steel sliding doors with recessed handle, 79"W x 32-1/4"D x 35-1/2"H, wet or dry operation, (5) 12" x 20" stainless steel sealed wells, individual infinite controls, drain manifold with valve, includes removable poly cutting board, stainless steel dish shelf, 430 stainless steel construction, end panel push bar on right, 4" swivel casters (2 with brakes), 3750 watts, 208v/60/1-ph, 17.2 amps, NEMA 6-30P, NSF, cULus  
Four (4) Model 421505 Flex-Master® Overshelf, for 5-well unit, 79"W x 15"D, posts sold separately, (require (2) pairs of posts) NSF

ITEM # 308                   SPARE NO.   <Spare No.>

ITEM # 309                   SPARE NO.   <Spare No.>

ITEM # 310.1                SOILED DISHTABLE

Quantity:                   One (1)  
Manufacturer:              Eagle Group or equal as approved by the Professional  
Model:                      UDT-4L-14/3

One (1) Model UDT-4L-14/3 Spec-Master® Undercounter Dishtable, dishwasher on left, 48"W x 27-1/2"D x 43-1/2"H overall, 14/304 stainless steel top, 20" x 20" x 5" pre-rinse sink includes basket drain with removable crumb cup, 8"H backsplash, single deck mount faucet hole for pre-rinse, raised rolled rims on front & sides, accommodates 24" (front-to-back) undercounter dishwasher, stainless steel legs & crossrails with adjustable metal feet, adjustable metal feet, NSF  
One (1) Model 606434 Pre-rinse Basket, 17-1/2"W x 19-1/2"L x 2"H, with slide bar, for dishtables, 304 type stainless steel  
One (1) Model 606641 Slanted Rack Shelf, solid, wall mount, 21"W x 19-3/4"D x 21-3/8"H, stainless steel wall brackets, stainless steel drip tube (right side), 16/304 stainless steel construction

ITEM # 310.2                SOILED DISHTABLE

Quantity:                   One (1)  
Manufacturer:              Eagle Group or equal as approved by the Professional  
Model:                      UDT-4R-14/3

One (1) Model UDT-4R-14/3 Spec-Master® Soiled Dishtable, undercounter, dishwasher on right, 48"W x 27-1/2"D x 43-1/2"H overall, 14/304 stainless steel top, 20" x 20" x 5" pre-rinse sink includes basket drain with removable crumb cup, 8"H backsplash, single deck mount faucet hole for pre-rinse, raised rolled rims on front & sides, accommodates 24" (front-to-back) undercounter dishwasher, stainless steel legs & crossrails with adjustable metal feet, adjustable metal feet, NSF  
One (1) Model 606434 Pre-rinse Basket, 17-1/2"W x 19-1/2"L x 2"H, with slide bar, for dishtables, 304 type stainless steel

One (1) Model 606641 Slanted Rack Shelf, solid, wall mount, 21"W x 19-3/4"D x 21-3/8"H, stainless steel wall brackets, stainless steel drip tube (right side), 16/304 stainless steel construction

ITEM # 311 PRE-RINSE FAUCET ASSEMBLY

Quantity: Two (2)  
Manufacturer: T&S Brass or equal as approved by the Professional  
Model: B-0113-BR

Two (2) Model B-0113-BR EasyInstall Pre-Rinse Unit, spring action gooseneck & hole base faucet, 1.15 GPM spray valve (B-0107), 44" flexible stainless steel hose, 24" riser, 18" flexible supply lines, 6" wall bracket, quarter-turn Eterna cartridges, low lead, 2019 DOE PRSV - Class II

ITEM # 312 DISHWASHER, UNDERCOUNTER

Quantity: Two (2)  
Manufacturer: Hobart or equal as approved by the Professional  
Model: CUH-1

Two (2) Model CUH-1 Centerline Dishwasher, undercounter, 22 11/16"W x 24"D x 32 5/16"H, high temperature sanitizing, (24) racks/hr, fresh water rinse, .84 gal/rack, delime notification and cycle, service diagnostics with error notifications, soft start, detergent & rinse aid pumps, 208-240v/60/1-ph, 24.2-27.5 amps, ships with (1) peg rack and (1) combo rack, cULus, NSF (Pricing options available, please contact your local rep for more information) (NET price shown)

Two (2) Standard warranty - 1-Year parts, labor & travel time during normal working hours within the USA

Two (2) Model PWRCORD-30A240V1P Power Cord Kit, 208-240v/60/1-ph, NEMA 6-30P plug included (net)

Four (4) Model DISHRAK-PEG20 Peg rack

Four (4) Model DISHRAK-COM20 Combination rack

ITEM # 313 (2) DISH SORT WALL SHELF INCLUDED WITH ITEM 210 <Included>

ITEM # 314 RACK DOLLY <By Owner>

Quantity: Two (2)  
Manufacturer: Metro or equal as approved by the Professional  
Model: DH2020N

Two (2) Model DH2020N Dish Rack Dolly, platform design, single stack, designed for 20" x 20" racks, tubular steel handle, 5" Heavy duty, non-marking, resilient tread swivel casters, bumper corners, all aluminum construction, with handle

ITEM # 315 SPARE NO. <Spare No.>

ITEM # 316 SPARE NO. <Spare No.>

ITEM # 317 (4) MILLWORK BEVERAGE COUNTERS - NIKEC <By G/C>

ITEM # 318 DROP-IN DUMP SINK

Quantity: Four (4)  
Manufacturer: BK Resources or equal as approved by the Professional  
Model: DDI-1014524S-P-G

Four (4) Model DDI-1014524S-P-G Deep Drawn Drop-In Sink, one compartment, 12-5/8"W x 18-1/2"D x 10-1/2"H overall size, (1) 10" wide x 14" front-to-back x 5" deep compartment, includes deck mount faucet (BKD-5G-G), 6"H splashes on sides & rear, includes basket drain (BKDR-4), 18/304 stainless steel construction, lead free, NSF

ITEM # 319 (4) COFFEE BREWERS - NIKEC <By Vendor>

ITEM # 320 (4) MILK COOLERS - NIKEC <By Vendor>

ITEM # 321 (4) JUICE DISPENSERS - NIKEC <By Vendor>

ITEM # 322 NUGGET ICE MAKER/ICE-WATER DISPENSER

Quantity: Four (4)  
Manufacturer: Manitowoc or equal as approved by the Professional  
Model: RNK0320AZ

Four (4) Model RNK0320AZ Ice Maker, nugget-style, air-cooled, self-contained condenser, 22"W x 23-5/8"D x 26"H, production capacity up to 308 lb/24 hours at 70°/50° (236 lb AHRI certified at 90°/70°), bite size nugget, high-load stainless steel bearings, stainless steel finish, 1/2 HP, R-404A, ETL-Sanitation, cETLus

Four (4) Model WARRANTY-RF/RFS/RNS 3 year parts & labor (Machine), 5 parts & 3 years labor (Compressor), standard

Four (4) (-251) 230v/50/1-ph, CE

Four (4) Model AR-10000-P Arctic Pure® Plus Primary Water Filter Assembly, includes head, shroud, hardware, mounting assembly, & (1) filter cartridge, 15,000 gallon capacity, 0-600 lbs./ice per day

Four (4) Model WARRANTY-ARCPURE 3 year parts & labor warranty on cap, housing, hardware, & mounting assembly (does not refer to filter cartridge), standard

Four (4) Model S-150-2704811 Ice Dispenser with Water Valve, countertop, 23"W x 31-1/8"D x 34-7/8"H, 150 lb. ice storage capacity, Rocking Chute™ ice dispensing, lever activated, includes: lighted merchandiser with "ice" graphics, leg kit and drain kit, stainless steel exterior, cUL, UL, NSF (apply Multiplex discount to this item)

Four (4) 1 year parts & labor warranty, standard

Four (4) 120v/60/1-ph, standard

Four (4) Model SL26-020000245 Bin Adapter, required for 22" cuber or nugget ice machine on an S-150 ice dispenser (apply Multiplex discount to this item)

Four (4) NOTE: Agitator and ice level management kit required for use with nugget ice machines on S-Dispensers

Four (4) Model K00488 Dispenser Thermostat Kit, reduces ice machine overflow & condensation problems, for use with nugget machines mounted to soda dispensers

ITEM # 323                    DROP-IN HAND SINK

Quantity:                    Four (4)  
Manufacturer:                BK Resources or equal as approved by the Professional  
Model:                        DDI-1014524S-P-G

Four (4) Model DDI-1014524S-P-G Deep Drawn Drop-In Sink, one compartment, 12-5/8"W x 18-1/2"D x 10-1/2"H overall size, (1) 10" wide x 14" front-to-back x 5" deep compartment, includes deck mount faucet (BKD-5G-G), 6"H splashes on sides & rear, includes basket drain (BKDR-4), 18/304 stainless steel construction, lead free, NSF

ITEM # 324                    UNDERCOUNTER REFRIGERATOR    <By Owner>

Quantity:                    Four (4)  
Manufacturer:                Continental Refrigerator or equal as approved by the Professional  
Model:                        SW32N-U

Four (4) Model SW32N-U Undercounter Refrigerator, 32"W, 9.0 cu ft capacity, one-section, (1) field rehingeable door, stainless steel front, top & end panels, aluminum interior, 1-3/8" diameter plate casters, front breathing, rear-mounted self-contained refrigeration, R290 Hydrocarbon refrigerant, 1/5 hp, cETLus, Made in USA, ENERGY STAR®  
Four (4) Standard warranty (for the United States & Canada Only): 3 year parts and labor; additional 4 year compressor part  
Four (4) 115v/60/1-ph, 2.46 amps, cord, NEMA 5-15P, standard  
Four (4) Door hinged on right, standard  
Four (4) Cylinder lock (per door/drawer)

ITEM # 325                    RACK DOLLY    <By Owner>

Quantity:                    Eight (8)  
Manufacturer:                Metro or equal as approved by the Professional  
Model:                        DH2020N

Eight (8) Model DH2020N Dish Rack Dolly, platform design, single stack, designed for 20" x 20" racks, tubular steel handle, 5" Heavy duty, non-marking, resilient tread swivel casters, bumper corners, all aluminum construction, with handle

**End of Section 114000**

## SECTION 11 52 13

### PROJECTION SCREENS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Electrically operated projection screens and controls.
- B. Related Requirements:
  - 1. Section 05 50 00 "Metal Fabrications" for metal support framing for projection screens.
  - 2. Section 06 10 53 "Miscellaneous Rough Carpentry" for wood backing for screen installation.

##### 1.3 DEFINITIONS

- A. Gain of Front-Projection Screens: Ratio of light reflected from screen material to that reflected perpendicularly from a magnesium carbonate surface as determined per SMPTE RP 94.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For projection screens. Show layouts and types of projection screens. Include the following:
  - 1. For manually operated projection screens:
    - a. Drop lengths.
    - b. Anchorage details.
    - c. Accessories.
  - 2. For electrically operated projection screens and controls:
    - a. Location of screen centerline relative to ends of screen case.
    - b. Location of wiring connections for electrically operated units.
    - c. Location of seams in viewing surfaces.
    - d. Drop lengths.
    - e. Anchorage details, including connection to supporting structure for suspended units.

- f. Details of juncture of exposed surfaces with adjacent finishes.
- g. Accessories.
- h. Wiring diagrams.

3. For rigid rear-projection screens:

- a. Frame details.
- b. Anchorage details.
- c. Details of juncture of exposed surfaces with adjacent finishes.
- d. Accessories.

C. Samples for Initial Selection: For finishes of surface-mounted screen cases.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For projection screens to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Source Limitations for Projection Screens: Obtain projection screens from single manufacturer. Obtain accessories, including necessary mounting hardware, from screen manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Environmental Limitations: Do not deliver or install projection screens until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.8 COORDINATION

- A. Coordinate layout and installation of projection screens with adjacent construction, including ceiling suspension systems, light fixtures, HVAC equipment, fire-suppression system, and partitions.

**PART 2 - PRODUCTS**

2.1 ELECTRICALLY OPERATED PROJECTION SCREENS

- A. General: Manufacturer's standard units consisting of case, screen, motor, controls, mounting accessories, and other components necessary for a complete installation. Provide units that are listed and labeled as an assembly by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

1. Controls: Remote, key-operated, three-position control switch installed in recessed device box with flush cover plate matching other electrical device cover plates in room where switch is installed.
    - a. Provide number of control switches indicated for each screen.
    - b. Provide power supply for low-voltage systems if required.
    - c. Provide locking cover plates for switches.
    - d. Provide key-operated, power-supply switch.
    - e. Provide infrared remote control consisting of battery-powered transmitter and receiver.
  2. Motor in Roller: Instant-reversing motor with permanently lubricated ball bearings, automatic thermal-overload protection, preset limit switches, and positive-stop action to prevent coasting.
  3. End-Mounted Motor: Instant-reversing, gear-drive motor with permanently lubricated ball bearings, automatic thermal-overload protection, preset limit switches, and positive-stop action to prevent coasting.
  4. Screen Mounting: Top edge securely anchored to rigid metal roller and bottom edge formed into a pocket holding a 3/8-inch- diameter metal rod with ends of rod protected by plastic caps.
    - a. Roller for end-mounted motor supported by self-aligning bearings in brackets.
    - b. Roller for motor in roller supported by vibration- and noise-absorbing supports.
- B. Suspended, Electrically Operated Screens without Ceiling Closure: Motor-in-roller or end-mounted motor units designed and fabricated for suspended mounting, with bottom of case entirely or partially open under screen compartment.
1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by the Professional:
    - a. Motor in Roller:
      - 1) BEI Audio-Visual Products; Alpine XL.
      - 2) Da-Lite Screen Company; Advantage Electrol.
      - 3) Draper Inc.; Paragon.
      - 4) Stewart Filmscreen Corporation; Model A-B.
    - b. End-Mounted Motor:
      - 1) Da-Lite Screen Company; Senior Electrol.
      - 2) Draper Inc.; Access/Series E.
      - 3) Stewart Filmscreen Corporation; Model B.
  2. Provide metal or metal-lined motor enclosure on units with end-mounted motor.
  3. Provide metal or metal-lined wiring compartment on units with motor in roller.
  4. Screen Case: Made from metal.
  5. Provide screen case with trim flange to receive ceiling finish.
  6. Finish on Exposed Surfaces: Vinyl covering or baked enamel.

## 2.2 FRONT-PROJECTION SCREEN MATERIAL

- A. Matte-White Viewing Surface: Peak gain not less than 0.9, and gain not less than 0.8 at an angle of 50 degrees from the axis of the screen surface.



1. Products: Subject to compliance with requirements, provide one of the following, or equal approved by the professional:
  - a. BEI Audio-Visual Products; Matte White.
  - b. Bretford, Inc.; Matte White.
  - c. Da-Lite Screen Company; Da-Mat.
  - d. Draper Inc.; Fiberglass Matte White.
- B. Material: Vinyl-coated, glass-fiber fabric or vinyl sheet.
- C. Mildew-Resistance Rating: 0 or 1 when tested according to ASTM G 21.
- D. Flame Resistance: Passes NFPA 701.
- E. Seams: Where length of screen indicated exceeds maximum length produced without seams in material specified, provide screen with horizontal seam placed as follows:
  1. At top of screen at juncture between extra drop length and viewing surface.
  2. In location indicated.
- F. Seamless Construction: Provide screens, in sizes indicated, without seams.
- G. Edge Treatment: Without black masking borders.
- H. Size of Viewing Surface: 72 by 96 inches.
- I.

### **PART 3 - EXECUTION**

#### **3.1 FRONT-PROJECTION SCREEN INSTALLATION**

- A. Install front-projection screens at locations indicated to comply with screen manufacturer's written instructions.
- B. Install front-projection screens with screen cases in position and in relation to adjoining construction indicated. Securely anchor to supporting substrate in a manner that produces a smoothly operating screen with vertical edges plumb and viewing surface flat when screen is lowered.
  1. Install low-voltage controls according to NFPA 70 and complying with manufacturer's written instructions.
    - a. Wiring Method: Install wiring in raceway except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
  2. Test electrically operated units to verify that screen controls, limit switches, closures, and other operating components are in optimum functioning condition.

**END OF SECTION 11 52 13**

**SECTION 12 24 13**  
**ROLLER WINDOW SHADES**

**PART 1 - GENERAL**

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Section Includes:

- 1. Manually operated roller shades with single rollers.
- 2. Motor-operated roller shades with single rollers.

B. Related Requirements:

- 1. Section 06 10 53 "Miscellaneous Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.
- 2. Section 07 92 00 "Joint Sealants" for sealing the perimeters of installation accessories for light-blocking shades with a sealant.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

- 1. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.

B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.

- 1. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified.

D. Samples for Initial Selection: For each type and color of shadeband material.

- 1. Include Samples of accessories involving color selection.

- E. Samples for Verification: For each type of roller shade.
  - 1. Shadeband Material: Not less than 10 inches square. Mark inside face of material if applicable.
  - 2. Roller Shade: Full-size operating unit, not less than 16 inches wide by 36 inches long for each type of roller shade indicated.
  - 3. Installation Accessories: Full-size unit, not less than 10 inches long.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of shadeband material, signed by product manufacturer.
- B. Product Test Reports: For each type of shadeband material, for tests performed by manufacturer and witnessed by a qualified testing agency.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roller shades to include in maintenance manuals.

#### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

#### 1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

### **PART 2 - PRODUCTS**

#### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain roller shades from single source from single manufacturer.

## 2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

- A. Basis-of-Design: Subject to compliance with requirements, provide MechoShade Systems, Inc; Mecho/5X or a comparable product by one of the following, or equal as approved by the Professional:
1. Draper Inc.
  2. Hunter Douglas Contract.
  3. Lutron Electronics Co., Inc.
- B. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
1. Bead Chains: Manufacturer's standard.
    - a. Loop Length: Full length of roller shade.
    - b. Limit Stops: Provide upper and lower ball stops.
    - c. Chain-Retainer Type: Clip, jamb mount.
  2. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller shade weight and for lifting heavy roller shades.
- C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
1. Roller Drive-End Location: Right side of inside face of shade unless right side of shade is obscured by a projecting wall.
  2. Direction of Shadeband Roll: Regular, from back (exterior face) of roller.
  3. Shadeband-to-Roller Attachment: Manufacturer's standard method.
- D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- E. Shadebands:
1. Shadeband Material: Light-filtering fabric,
    - a. except at Veterans' Hall exterior doors use Light-blocking fabric.
  2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
    - a. Type: Enclosed in sealed pocket of shadeband material.
    - b. Color and Finish: As selected from manufacturer's full range.
- F. Installation Accessories:
1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
    - a. Shape: L-shaped.
    - b. Height: Manufacturer's standard height required to conceal roller and shadeband when shade is fully open, but not less than 4 inches.

2. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.
  - a. Height: Manufacturer's standard height required to enclose roller and shadeband when shade is fully open, but not less than 4 inches.
3. Endcap Covers: To cover exposed endcaps.
4. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.
5. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.
6. Installation Accessories Color and Finish: As selected from manufacturer's full range.

### 2.3 MOTOR-OPERATED, SINGLE-ROLLER SHADES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide MechoShade Systems, Inc.; ElectroShade or a comparable product by one of the following, or equal approved by the Professional:
  1. Draper Inc.
  2. Lutron Electronics Co., Inc.
- B. Motorized Operating System: Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-rewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
  1. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. Electric Motor: Manufacturer's standard tubular, enclosed in roller.
  3. Remote Control: Electric controls with NEMA ICS 6, Type 1 enclosure for recessed or flush mounting. Provide the following for remote-control activation of shades:
    - a. Group Control Station: Momentary-contact, three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for single-switch group control.
    - b. Color: As selected by Architect from manufacturer's full range.
  4. Limit Switches: Adjustable switches interlocked with motor controls and set to stop shades automatically at fully raised and fully lowered positions.
  5. Operating Features:
    - a. Group switching with integrated switch control; single faceplate for multiple switch cutouts.
- C. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
  1. Bead Chains: Manufacturer's standard.
    - a. Loop Length: Full length of roller shade.
    - b. Limit Stops: Provide upper and lower ball stops.

- c. Chain-Retainer Type: Clip, jamb mount.
- 2. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller shade weight and for lifting heavy roller shades.
- D. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
  - 1. Roller Drive-End Location: Right side of inside face of shade unless right side of shade is obscured by a projecting wall.
  - 2. Direction of Shadeband Roll: Regular, from back (exterior face) of roller.
  - 3. Shadeband-to-Roller Attachment: Manufacturer's standard method.
- E. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- F. Shadebands:
  - 1. Shadeband Material: Light-blocking fabric at Veterans' Hall exterior windows.
  - 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
    - a. Type: Enclosed in sealed pocket of shadeband materials.
    - b. Color and Finish: As selected by Architect from manufacturer's full range.
- G. Installation Accessories:
  - 1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
    - a. Shape: L-shaped.
    - b. Height: Manufacturer's standard height required to conceal roller and shadeband when shade is fully open, but not less than 3 inches.
  - 2. Endcap Covers: To cover exposed endcaps.
  - 3. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.
  - 4. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.
  - 5. Installation Accessories Color and Finish: As selected from manufacturer's full range.

## 2.4 SHADEBAND MATERIALS

- A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.
  - 1. Source: Roller-shade manufacturer.
  - 2. Type: PVC-coated polyester.
  - 3. Weave: Basketweave.

4. Orientation on Shadeband: Up the bolt.
5. Openness Factor: 3 percent.
6. Color: Phifer Sheer Weave 4400, Color: Alabaster.

C. Light-Blocking Fabric: Opaque fabric, stain and fade resistant.

1. Source: Roller-shade manufacturer.
2. Type: Polyester-cotton blend.
3. Orientation on Shadeband: Up the bolt.
4. Features: Washable.
5. Color: Phifer – Infinity 2, 1% openness, room darkening shades; color PG1 Cotton

## 2.5 ROLLER-SHADE FABRICATION

A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.

B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:

1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side or 1/2-inch total, plus or minus 1/8 inch. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch, plus or minus 1/8 inch.
2. Outside of Jamb Installation: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.

C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible except as follows:

1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.
2. Railroaded Materials: Railroad material where material roll width is less than the required width of shadeband and where indicated. Provide battens and seams as required by railroaded material to produce shadebands with full roll-width panel(s) plus, if required, one partial roll-width panel located at top of shadeband.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, accurate locations of connections to building electrical system, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 ROLLER-SHADE INSTALLATION

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.
  - 1. Opaque Shadebands: Located so shadeband is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.
- B. Electrical Connections: Connect motor-operated roller shades to building electrical system.

### 3.3 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

### 3.4 CLEANING AND PROTECTION

- A. Clean roller-shade surfaces after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

### 3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor-operated roller shades.

**END OF SECTION 12 24 13**



## SECTION 12 36 23.13

### PLASTIC-LAMINATE-CLAD COUNTERTOPS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section includes plastic-laminate countertops.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, including panel products high-pressure decorative laminate and adhesive for bonding plastic laminate.
  - 1. For adhesives used on the interior of the building, include a statement of VOC content in g/L.
  - 2. For adhesives and composite wood products used on the interior of the building, indicate that products contain no added urea formaldehyde resins.
- B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
  - 1. Show locations and sizes of cutouts and holes for plumbing fixtures and other items installed in plastic-laminate countertops.
- C. Samples: Plastic laminates, for each color, pattern, and surface finish.
- D. Samples for Verification: Plastic laminates, 8 by 10 inches, for each type, color, pattern, and surface finish.

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and fabricator.
- B. Product Certificates: For the following:
  - 1. Composite wood and agrifiber products.
  - 2. High-pressure decorative laminate.
  - 3. Adhesives.

## 1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver countertops until painting and similar operations that could damage countertops have been completed in installation areas. If countertops must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

## 1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install countertops until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Established Dimensions: Where countertops are indicated to fit to other construction, establish dimensions for areas where countertops are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

## PART 2 - PRODUCTS

### 2.1 PLASTIC-LAMINATE COUNTERTOPS

- A. High-Pressure Decorative Laminate: NEMA LD 3, Grade HGS.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by the Professional:
    - a. Abet Laminati, Inc.
    - b. Formica Corporation.
    - c. Lamin-Art, Inc.
    - d. Panolam Industries International, Inc.
    - e. Wilsonart International; Div. of Premark International, Inc.
- B. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
  - 1. As indicated on Drawings by manufacturer's designations.
- C. Edge Treatment: Same as laminate cladding on horizontal surfaces.
- D. Core Material: Particleboard.
- E. Core Material at Sinks: Particleboard made with exterior glue.
- F. Core Thickness: 3/4 inch.

1. Build up countertop thickness to 1-1/2 inches at front, back, and ends with additional layers of core material laminated to top.
- G. Backer Sheet: Provide plastic-laminate backer sheet, NEMA LD 3, Grade BKL, on underside of countertop substrate.
- H. Paper Backing: Provide paper backing on underside of countertop substrate.

## 2.2 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard unless otherwise indicated.
- B. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of referenced quality standard for each type of woodwork and quality grade specified unless otherwise indicated.
1. Particleboard: ANSI A208.1, Grade M-2, made with binder containing no added urea formaldehyde resins.
  2. Softwood Plywood: DOC PS 1.

## 2.3 ACCESSORIES

- A. Grommets for Cable Passage through Countertops: 2-inch OD, black, molded-plastic grommets and matching plastic caps with slot for wire passage.

## 2.4 MISCELLANEOUS MATERIALS

- A. Adhesives: Do not use adhesives that contain added urea formaldehyde resins.
- B. VOC Limits for Installation Adhesives and Sealants: All adhesives and sealants used on the interior of the building shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1. Wood Glues: 30 g/L.
  2. Multipurpose Construction Adhesives: 70 g/L.
  3. Structural Wood Member Adhesive: 140 g/L.
  4. Architectural Sealants: 250 g/L.

## 2.5 FABRICATION

- A. Fabricate countertops to dimensions, profiles, and details indicated. Provide front and end overhang of 1 inch over base cabinets. Ease edges to radius indicated for the following:
1. Solid-Wood (Lumber) Members: 1/16 inch unless otherwise indicated.
- B. Complete fabrication, including assembly, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Before installation, condition countertops to average prevailing humidity conditions in installation areas.
- B. Before installing countertops, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

#### **3.2 INSTALLATION**

- A. Assemble countertops and complete fabrication at Project site to the extent that it was not completed in the shop.
  1. Provide cutouts for appliances, plumbing fixtures, electrical work, and similar items.
  2. Seal edges of cutouts by saturating with varnish.
- B. Field Jointing: Where possible, make in the same manner as shop jointing, using dowels, splines, adhesives, and fasteners recommended by manufacturer. Prepare edges to be joined in shop so Project-site processing of top and edge surfaces is not required. Locate field joints where shown on Shop Drawings.
  1. Secure field joints in plastic-laminate countertops with concealed clamping devices located within 6 inches of front and back edges and at intervals not exceeding 24 inches. Tighten according to manufacturer's written instructions to exert a constant, heavy-clamping pressure at joints.
- C. Install countertops level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.
- D. Scribe and cut countertops to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
  1. Install countertops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
  2. Secure backsplashes to walls with adhesive.
  3. Seal junctures of tops, splashes, and walls with mildew-resistant silicone sealant or another permanently elastic sealing compound recommended by countertop material manufacturer.

3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective countertops, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- B. Clean countertops on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

**END OF SECTION 12 36 23.13**

## SECTION 12 36 61

### SIMULATED STONE COUNTERTOPS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Solid-surface-material countertops and backsplashes.
  - 2. Quartz agglomerate countertops and backsplashes.
- B. Related Requirements:
  - 1. Section 22 41 00 "Residential Plumbing Fixtures" for sinks and plumbing fittings.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For countertop materials.
  - 1. For adhesives and composite wood products used on the interior of the building, indicate that product contains no added urea formaldehyde resins.
- B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
- C. Samples: For each type of material exposed to view.
- D. Samples for Verification: For the following products:
  - 1. Countertop material, 6 inches square.
  - 2. One full-size solid-surface-material countertop, with front edge, 8 by 10 inches, of construction and in configuration specified.
  - 3. One full-size quartz agglomerate countertop, with front edge, 8 by 10 inches, of construction and in configuration specified.

##### 1.4 PROJECT CONDITIONS

- A. Field Measurements: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete.

##### 1.5 COORDINATION

- A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

## PART 2 - PRODUCTS

### 2.1 SOLID-SURFACE-MATERIAL COUNTERTOPS

- A. Configuration: Provide countertops with the following front and backsplash style:
  - 1. Front: Straight, slightly eased at top.
  - 2. Backsplash: Straight, slightly eased at corner.
  - 3. Endsplash: Matching backsplash.
- B. Countertops: 3/4-inch-thick, solid surface material with front edge built up with same material.
- C. Backsplashes: 3/4-inch-thick, solid surface material.
- D. Fabrication: Fabricate tops in one piece with shop-applied edges and backsplashes unless otherwise indicated. Comply with solid-surface-material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.

### 2.2 QUARTZ AGGLOMERATE COUNTERTOPS

- A. Configuration: Provide countertops with the following front and backsplash style:
  - 1. Front: Straight, slightly eased at top.
  - 2. Backsplash: Straight, slightly eased at corner.
  - 3. Endsplash: Matching backsplash.
- B. Countertops: 3/4-inch-thick, quartz agglomerate with front edge built up with same material.
- C. Backsplashes: 3/4-inch-thick, quartz agglomerate.
- D. Fabrication: Fabricate tops in one piece with shop-applied edges and backsplashes unless otherwise indicated. Comply with quartz agglomerate manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.

### 2.3 COUNTERTOP MATERIALS

- A. Particleboard: ANSI A208.1, Grade M-2, made with binder containing no added urea formaldehyde resins.
- B. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.
- C. Adhesives: Adhesives shall not contain added urea formaldehyde resins.
- D. Solid Surface Material: Homogeneous solid sheets of filled plastic resin complying with ANSI SS1.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by the Professional:
    - a. Avonite Surfaces.
    - b. E. I. du Pont de Nemours and Company.

- c. Formica Corporation.
  - d. LG Chemical, Ltd.
  - e. Meganite Inc.
  - f. Samsung Chemical USA, Inc.
  - g. Swan Corporation (The).
  - h. Transolid, Inc.
  - i. Wilsonart International.
2. Type: Provide Standard Type or Veneer Type made from material complying with requirements for Standard Type, as indicated unless Special Purpose Type is indicated.
  3. Colors and Patterns: As indicated on Drawings by manufacturer's designations.
- E. Quartz Agglomerate: Solid sheets consisting of quartz aggregates bound together with a matrix of filled plastic resin and complying with the "Physical Characteristics of Materials" Article of ANSI SS1.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal approved by the Professional:
    - a. Cambria.
    - b. Cosentino USA.
    - c. E. I. du Pont de Nemours and Company.
    - d. LG Chemical, Ltd.
    - e. Meganite Inc.
    - f. Samsung Chemical USA, Inc.
    - g. Technistone USA, Inc.
    - h. Transolid, Inc.
  2. Colors and Patterns: As indicated on Drawings by manufacturer's designations.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install countertops level to a tolerance of 1/8 inch in 8 feet.
- B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Pre-drill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
  1. Install backsplashes and endsplashes to comply with manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
  2. Seal edges of cutouts in particleboard subtops by saturating with varnish.

**END OF SECTION 12 36 61**



## SECTION 14 24 00

### HYDRAULIC ELEVATORS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section includes hydraulic passenger and service elevators.
- B. Related Requirements:
  - 1. Section 03 30 00 "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
  - 2. Section 04 20 00 "Unit Masonry" for setting sleeves, inserts, and anchoring devices in masonry and for grouting elevator entrance frames installed in masonry walls.
  - 3. Section 05 50 00 "Metal Fabrications" for the following:
    - a. Attachment plates and angle brackets for supporting guide-rail brackets.
    - b. Divider beams.
    - c. Hoist beams.
    - d. Structural-steel shapes for subsills.
    - e. Pit ladders.
  - 4. Section 09 91 13 "Exterior Painting" for field painting of hoistway entrance doors and frames.
  - 5. Section 09 91 23 "Interior Painting" for field painting of hoistway entrance doors and frames.
  - 6. Section 22 14 29 "Sump Pumps" for sump pumps, sumps, and sump covers in elevator pits.
  - 7. Section 27 15 00 "Communications Horizontal Cabling" for telephone service for elevators.
  - 8. Section 28 05 00 "Common Work Elements for Electrical Safety and Security for smoke detectors in elevator lobbies to initiate emergency recall operation and heat detectors in shafts and machine rooms to disconnect power from elevator equipment before sprinkler activation and for connection to elevator controllers.
  - 9. Section 28 13 00 "Access Control System" for card reader access to elevators.
  - 10. Section 31 20 00 "Earth Moving" for excavating well hole to accommodate cylinder assembly.

##### 1.3 DEFINITIONS

- A. Definitions in ASME A17.1/CSA B44 apply to work of this Section.
- B. Service Elevator: A passenger elevator that is also used to carry freight.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include product data for car enclosures, hoistway entrances, and operation, control, and signal systems.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and large-scale details indicating service at each landing, machine room layout, coordination with building structure, relationships with other construction, and locations of equipment.
  - 2. Indicate maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.
- C. Samples: For exposed finishes.
- D. Samples for Verification: For exposed car, hoistway door and frame, and signal equipment finishes; 3-inch- square Samples of sheet materials; and 4-inch lengths of running trim members.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For elevator equipment, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and machine room layout and dimensions, as shown on Drawings, and electrical service including standby power generator, as shown and specified, are adequate for elevator system being provided.
- C. Sample Warranty: For special warranty.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.
- B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.
  - 1. The Elevator Contractor shall obtain and pay for necessary Municipal and State Inspection and permit as required by the elevator inspection authority, and make such tests as are called for by the regulations or such authorities. These tests shall be made in the presence of such authorities or their authorized representatives.

- C. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to Owner, in the form of a standard one-year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

#### 1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Elevator manufacturer shall be ISO 9002 certified.
- B. Installer Qualifications: Elevator manufacturer.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle materials, components and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

#### 1.9 COORDINATION

- A. Coordinate installation of sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.
- B. Coordinate locations and dimensions of other work relating to hydraulic elevators including pit ladders; sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways, pits, and machine rooms.

#### 1.10 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.
  - 2. Warranty Period: Two years from date of Substantial Completion.

### **PART 2 - PRODUCTS**

#### 2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Otis Elevator Co. Gen 2 – 2500; Gen 2 - 3500, and Gen 2 - 4500 or comparable product by one of the following, or equal approved by Professional:
  - 1. Otis Elevator Co.
  - 2. Schindler Elevator Corp.

3. ThyssenKrupp Elevator.

B. Source Limitations: Obtain elevators from single manufacturer.

1. Major elevator components, including pump-and-tank units, plunger-cylinder assemblies, controllers, signal fixtures, door operators, car frames, cars, and entrances, shall be manufactured by single manufacturer.

## 2.2 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with ASME A17.1/CSA B44 and requirements of authorities having jurisdiction.

B. Accessibility Requirements: Comply with Section 407 in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and with ICC A117.1.

C. Seismic Performance: Elevator system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and shall comply with elevator safety requirements for seismic risk Zone 2 or greater in ASME A17.1/CSA B44.

1. Affected peak velocity acceleration ( $A_v$ ) for Project's location is less than 0.10 (seismic risk Zones 0 and 1).
2. Provide earthquake equipment required by ASME A17.1/CSA B44.
3. Design earthquake spectral response acceleration short period ( $S_d$ s) for Project is 0.121G.
4. Project's Seismic Design Category: B.
5. Elevator Component Importance Factor: 1.0.

## 2.3 ELEVATORS

A. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturers' standard components shall be used, as included in standard elevator systems and as required for complete system.

B. Elevator Description:

1. Elevator Number(s): Public E-1 and E-2 (Basis-of-Design: Otis, Gen 2 - 3500).
2. Type: Holeless, beside-the-car, telescoping, dual cylinder.
3. Rated Load: 3500 lb.
4. Freight Loading Class for Service Elevators: Class A.
5. Rated Speed: 125 fpm.
6. Operation System: Group automatic.
7. Auxiliary Operations:
  - a. Standby power operation.
  - b. Battery-powered lowering.
  - c. Automatic dispatching of loaded car.
  - d. Nuisance call cancel.
  - e. Independent service for all cars in group.
  - f. Loaded-car bypass.
8. Security Features: Keyswitch operation.
9. Car Enclosures:
  - a. Inside Height: 7'- 9" to underside of ceiling.

- b. Front Walls (Return Panels): Satin stainless steel, No. 4 finish with integral car door frames.
  - c. Car Fixtures: Satin stainless steel, No. 4 finish.
  - d. Side and Rear Wall Panels: Plastic Laminate.
  - e. Reveals: Satin stainless steel, No. 4 finish.
  - f. Door Faces (Interior): Satin stainless steel, No. 4 finish.
  - g. Door Sills: Aluminum, mill finish.
  - h. Ceiling: Satin stainless steel, No. 4 finish.
  - i. Handrails: 1-1/2 inches round satin stainless steel, No. 4 finish, at sides and rear of car.
  - j. Floor prepared to receive resilient flooring (specified in Section 09 65 10 "Resilient Flooring and Accessories").
10. Hoistway Entrances:
- a. Width: 3'-6".
  - b. Height: 7'-0".
  - c. Type: Single-speed side sliding.
  - d. Frames: Satin stainless steel, No. 4 finish.
  - e. Doors: Satin stainless steel, No. 4 finish.
  - f. Sills: Aluminum, mill finish.
11. Hall Fixtures: Satin stainless steel, No. 4 finish.
12. Additional Requirements:
- a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, No. 4 finish.

C. Elevator Description:

- 1. Service Elevator Number(s): E-3 and E-4 (Basis-of-Design: Otis, Gen 2 - 4500).
- 2. Type: Holeless, beside-the-car, telescoping, dual cylinder.
- 3. Rated Load: 4500 lb.
- 4. Freight Loading Class for Service Elevators: Class A.
- 5. Rated Speed: 125 fpm.
- 6. Operation System: Group automatic.
- 7. Auxiliary Operations:
  - a. Standby power operation.
  - b. Battery-powered lowering.
  - c. Automatic dispatching of loaded car.
  - d. Nuisance call cancel.
  - e. Independent service for all cars in group.
  - f. Loaded-car bypass.
- 8. Security Features: Keyswitch operation.
- 9. Car Enclosures:
  - a. Inside Height: 7'- 11" to underside of ceiling.
  - b. Front Walls (Return Panels): Satin stainless steel, No. 4 finish with integral car door frames.
  - c. Car Fixtures: Satin stainless steel, No. 4 finish.
  - d. Side and Rear Wall Panels: Satin stainless steel, No. 4 finish.
  - e. Reveals: Satin stainless steel, No. 4 finish.
  - f. Door Faces (Interior): Satin stainless steel, No. 4 finish.
  - g. Door Sills: Aluminum, mill finish.
  - h. Ceiling: Luminous ceiling.
  - i. Handrails: 1/2 by 2 inches rectangular satin stainless steel, No. 4 finish, at sides and rear of car.
  - j. Floor prepared to receive resilient flooring (specified in Section 09 65 10 "Resilient Flooring and Accessories").

10. Hoistway Entrances:
  - a. Width: 4'-0".
  - b. Height: 7'-0".
  - c. Type: Two-speed side sliding.
  - d. Frames: Satin stainless steel, No. 4 finish.
  - e. Doors: Satin stainless steel, No. 4 finish.
  - f. Sills: Aluminum, mill finish.
11. Hall Fixtures: Satin stainless steel, No. 4 finish.
12. Additional Requirements:
  - a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, No. 4 finish.
  - b. Provide hooks for protective pads in all cars and two complete sets of full-height protective pads.

D. Elevator Description:

1. Elevator Number(s): Public E-5 (Basis-of-Design: Otis, Gen 2 - 2500).
2. Type: Holeless, beside-the-car, telescoping, dual cylinder.
3. Rated Load: 2500 lb.
4. Freight Loading Class for Service Elevators: Class A.
5. Rated Speed: 125 fpm.
6. Operation System: Single automatic.
7. Auxiliary Operations:
  - a. Standby power operation.
  - b. Battery-powered lowering.
  - c. Automatic dispatching of loaded car.
  - d. Nuisance call cancel.
  - e. Loaded-car bypass.
8. Security Features: Keyswitch operation.
9. Car Enclosures:
  - a. Inside Height: 7'-9" to underside of ceiling.
  - b. Front Walls (Return Panels): Satin stainless steel, No. 4 finish with integral car door frames.
  - c. Car Fixtures: Satin stainless steel, No. 4 finish.
  - d. Side and Rear Wall Panels: Plastic Laminate.
  - e. Reveals: Satin stainless steel, No. 4 finish.
  - f. Door Faces (Interior): Satin stainless steel, No. 4 finish.
  - g. Door Sills: Aluminum, mill finish.
  - h. Ceiling: Satin stainless steel, No. 4 finish.
  - i. Handrails: 1-1/2 inches round satin stainless steel, No. 4 finish, at sides and rear of car.
  - j. Floor prepared to receive resilient flooring (specified in Section 09 65 10 "Resilient Flooring and Accessories").
10. Hoistway Entrances:
  - a. Width: 3'-6".
  - b. Height: 7'-0".
  - c. Type: Single-speed side sliding.
  - d. Frames: Satin stainless steel, No. 4 finish.
  - e. Doors: Satin stainless steel, No. 4 finish.
  - f. Sills: Aluminum, mill finish.
11. Hall Fixtures: Satin stainless steel, No. 4 finish.
12. Additional Requirements:

- a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, No. 4 finish.

## 2.4 SYSTEMS AND COMPONENTS

- A. Pump Units: Positive-displacement type with a maximum of 10 percent variation between no load and full load and with minimum pulsations.
  - 1. Pump shall be submersible type with submersible squirrel-cage induction motor, and shall be suspended inside oil tank from vibration isolation mounts or shall be tank-top-mounted type with fan-cooled, squirrel-cage induction motor, and shall be mounted on oil tank with vibration isolation mounts and enclosed in prime-painted steel enclosure lined with 1-inch-thick, glass-fiber insulation board.
  - 2. Motor shall have wye-delta or solid-state starting.
- B. Hydraulic Silencers: System shall have hydraulic silencer containing pulsation-absorbing material in blowout-proof housing at pump unit.
- C. Piping: Size, type, and weight of piping as recommended by elevator manufacturer, with flexible connectors to minimize sound and vibration transmissions from power unit.
- D. Hydraulic Fluid: Nontoxic, biodegradable, fire-resistant fluid made from vegetable oil with antioxidant, anticorrosive, antifoaming, and metal-passivating additives and approved by elevator manufacturer for use with elevator equipment.
- E. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work. Device installation is specified in another Section.
- F. Car Frame and Platform: Welded steel units.
- G. Guides: Roller guides; polymer-coated, nonlubricated sliding guides; or sliding guides with guide-rail lubricators. Provide guides at top and bottom of car and counterweight frames.

## 2.5 OPERATION SYSTEMS

- A. General: Provide manufacturer's standard microprocessor operation system as required to provide type of operation indicated.
- B. Auxiliary Operations: In addition to primary operation system features, provide the following operational features for elevators where indicated:
  - 1. Group Standby Power Operation: On activation of standby power, cars are returned to lowest floor and parked with doors open. If a car cannot be returned, it is removed from the system. One car is selected for service on standby power by a switch located at main lobby.
  - 2. Group Battery-Powered Lowering: When power fails, cars are lowered to the lowest floor, open their doors, and shut down. System includes rechargeable battery and automatic recharging system.
  - 3. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors start closing.
  - 4. Nuisance Call Cancel: When car calls exceed a preset number while car load is less than a predetermined weight, all car calls are canceled. Preset number of calls and predetermined weight can be adjusted.

5. Loaded-Car Bypass: When car load exceeds 80 percent of rated capacity, car responds only to car calls, not to hall calls.
6. Independent Service: Keyswitch in car-control station removes car from group operation and allows it to respond only to car calls. Key cannot be removed from keyswitch when car is in independent service. When in independent service, doors close only in response to door close button.

## 2.6 DOOR REOPENING DEVICES

- A. Infrared Array: Provide door reopening device with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more light beams shall cause doors to stop and reopen.
- B. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door reopening device, a loud buzzer shall sound and doors shall begin to close at reduced kinetic energy.

## 2.7 CAR ENCLOSURES

- A. General: Provide steel-framed car enclosures with nonremovable wall panels, with car roof, access doors, power door operators, and ventilation.
  1. Provide standard railings complying with ASME A17.1/CSA B44 on car tops where required by ASME A17.1/CSA B44.
- B. Materials and Finishes: Manufacturer's standards, but not less than the following:
  1. Subfloor: Exterior, underlayment grade plywood, not less than 5/8-inch nominal thickness.
  2. Stainless-Steel Wall Panels: Flush, hollow-metal construction; fabricated from stainless-steel sheet.
  3. Fabricate car with recesses and cutouts for signal equipment.
  4. Stainless-Steel Doors: Flush, hollow-metal construction; fabricated from stainless-steel sheet.
  5. Sight Guards: Provide sight guards on car doors.
  6. Sills: Extruded metal, with grooved surface, 1/4 inch thick.
  7. Luminous Ceiling: Fluorescent light fixtures and ceiling panels of translucent acrylic or other permanent rigid plastic.
  8. Metal Ceiling: Flush panels, with four low-voltage downlights in each panel. Align ceiling panel joints with joints between wall panels.
  9. Handrails: Manufacturer's standard handrails, of shape, metal, and finish indicated.

## 2.8 HOISTWAY ENTRANCES

- A. Hoistway Entrance Assemblies: Manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Frame size and profile shall accommodate hoistway wall construction.
  1. Where gypsum board wall construction is indicated, frames shall be self-supporting with reinforced head sections.



- B. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies shall comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction based on testing at as close-to-neutral pressure as possible according to NFPA 252 or UL 10B.
  - 1. Fire-Protection Rating: 1-1/2 hours with 30-minute temperature rise of 450 deg F.
- C. Materials and Fabrication: Manufacturer's standards, but not less than the following:
  - 1. Stainless-Steel Frames: Formed from stainless-steel sheet.
  - 2. Star of Life Symbol: Identify emergency elevators with star of life symbol, not less than 3 inches high, on both inside surfaces of hoistway door frames.
  - 3. Stainless-Steel Doors: Flush, hollow-metal construction; fabricated from stainless-steel sheet.
  - 4. Sight Guards: Provide sight guards on doors matching door edges.
  - 5. Sills: Extruded metal, with grooved surface, 1/4 inch thick.
  - 6. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M.

## 2.9 SIGNAL EQUIPMENT

- A. General: Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Fabricate lighted elements with long-life lamps and acrylic or other permanent, non-yellowing translucent plastic diffusers or LEDs.
- B. Car-Control Stations: Provide manufacturer's standard recessed car-control stations. Mount in return panel adjacent to car door unless otherwise indicated.
  - 1. Mark buttons and switches for required use or function. Use both tactile symbols and Braille.
  - 2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.
- C. Emergency Communication System: Two-way voice communication system, with visible signal, which dials preprogrammed number of monitoring station and does not require handset use. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.
- D. Firefighters' Two-Way Telephone Communication Service: Provide flush-mounted cabinet in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in Section 27 21 00 "Two-Way Communication System"
- E. Car Position Indicator: Provide illuminated, digital-type car position indicator, located above car door or above car-control station. Also, provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served. Include travel direction arrows if not provided in car-control station.
- F. Hall Push-Button Stations: Provide hall push-button station at each landing as indicated on Drawings.
  - 1. Provide units with flat faceplate for mounting with body of unit recessed in wall.
  - 2. Equip units with buttons for calling elevator and for indicating desired direction of travel.
  - 3. Provide telephone jack in each unit for firefighters' two-way telephone communication service specified in Section 27 21 00 "Two-Way Communication Systems"

- G. Hall Lanterns: Units with illuminated arrows; but provide single arrow at terminal landings. Provide the following:
  - 1. Manufacturer's standard wall-mounted units, for mounting above entrance frames.
- H. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.
  - 1. At manufacturer's option, audible signals may be placed on cars.
- I. Hall Position Indicators: Provide illuminated, digital-display-type position indicators, located above each hoistway entrance at ground floor. Provide units with flat faceplate for mounting and with body of unit recessed in wall.
  - 1. Integrate ground-floor hall lanterns with hall position indicators.
- J. Standby Power Elevator Selector Switches: Provide switches, as required by ASME A17.1/CSA B44, where indicated. Adjacent to switches, provide illuminated signal that indicates when normal power supply has failed. For each elevator, provide illuminated signals that indicate when they are operational and when they are at the designated emergency return level with doors open.
- K. Fire-Command-Center Annunciator Panel: Provide panel containing illuminated position indicators for each elevator, clearly labeled with elevator designation; include illuminated signal that indicates when elevator is operational and when it is at the designated emergency return level with doors open. Provide standby power elevator selector switch(es), as required by ASME A17.1/CSA B44, adjacent to position indicators. Provide illuminated signal that indicates when normal power supply has failed.
- L. Emergency Pictorial Signs: Fabricate from materials matching hall push-button stations, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station unless otherwise indicated.

## 2.10 FINISH MATERIALS

- A. General: Provide the following materials for exposed parts of elevator car enclosures, car doors, hoistway entrance doors and frames, and signal equipment as indicated.
- B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.
- C. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel, Type B, pickled.
- D. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.
- E. Stainless-Steel Bars: ASTM A 276, Type 304.
- F. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.
- G. Aluminum Extrusions: ASTM B 221, Alloy 6063.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Verify critical dimensions and examine supporting structure and other conditions under which elevator work is to be installed.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Comply with manufacturer's written instructions.
- B. Install cylinder plumb and accurately centered for elevator car position and travel. Anchor securely in place, supported at pit floor and braced at intervals as needed to maintain alignment. Anchor cylinder guides at spacing needed to maintain alignment and avoid overstressing guides.
- C. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS workmanship and welding operator qualification standards.
- D. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.
- E. Install piping above the floor, where possible. Install underground piping in casing.
- F. Lubricate operating parts of systems as recommended by manufacturers.
- G. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay installation of sills and frames until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.
- H. Leveling Tolerance: 1/4 inch, up or down, regardless of load and travel direction.
- I. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.
- J. Locate hall signal equipment for elevators as follows, unless otherwise indicated:
  - 1. For groups of elevators, locate hall push-button stations between two elevators at center of group or at location most convenient for approaching passengers.
  - 2. Place hall lanterns either above or beside each hoistway entrance.
  - 3. Mount hall lanterns at a minimum of 72 inches above finished floor.

### 3.3 FIELD QUALITY CONTROL

- A. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.
- B. Apply for registration form for each elevator.
- C. At least 15 days before a scheduled final acceptance inspection, submit to the Commissioner a written certification that:
  - 1. The elevator meets the requirements of the elevator safety code.
  - 2. A Third Party Qualified Elevator Inspector has certified that the elevator unit, as constructed and installed, complies with the Laws and Regulations of the Commonwealth of Pennsylvania.
  - 3. The elements indicated on the inspection checklist are operational, have been tested, and are functional.
- D. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times that tests are to be performed on elevators.

### 3.4 PROTECTION

- A. Temporary Use: Limit temporary use for construction purposes to one elevator. Comply with the following requirements for elevator used for construction purposes:
  - 1. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
  - 2. Provide strippable protective film on entrance and car doors and frames.
  - 3. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
  - 4. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
  - 5. Do not load elevators beyond their rated weight capacity.
  - 6. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleanup, and adjustment as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
  - 7. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

### 3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate, adjust, and maintain elevator(s).
- B. Check operation of each elevator with Owner's personnel present before date of Substantial Completion and again not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

### 3.6 MAINTENANCE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
1. Perform maintenance during normal working hours.
  2. Include 24-hour-per-day, 7-day-per-week emergency callback service with response time of two hours or less.

**END OF SECTION 14 24 00**

## SECTION 21 05 13

### COMMON MOTOR REQUIREMENTS FOR FIRE SUPPRESSION EQUIPMENT

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

##### 1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
  - 1. Motor controllers.
  - 2. Torque, speed, and horsepower requirements of the load.
  - 3. Ratings and characteristics of supply circuit and required control sequence.
  - 4. Ambient and environmental conditions of installation location.

#### PART 2 - PRODUCTS

##### 2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. Comply with IEEE 841 for severe-duty motors.

##### 2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 ft. (1000 m) above sea level.

- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

## 2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
  - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
  - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors, Multiple Winding: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F.
- J. Code Letter Designation:
  - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
  - 2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

## 2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
  - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
  - 2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
  - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
  - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

## 2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp must be one of the following, to suit starting torque and requirements of specific motor application:
  - 1. Permanent-split capacitor.
  - 2. Split phase.
  - 3. Capacitor start, inductor run.
  - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device will automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 21 05 13



## SECTION 21 05 17

### SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section Includes:
  - 1. Sleeves.
  - 2. Stack-sleeve fittings.
  - 3. Sleeve-seal systems.
  - 4. Sleeve-seal fittings.
  - 5. Grout.
  - 6. Silicone sealants.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

##### 1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

#### PART 2 - PRODUCTS

##### 2.1 SLEEVES

- A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.
- B. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, anticorrosion coated or galvanized, with plain ends and integral welded waterstop collar.

- C. Galvanized-Steel Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

## 2.2 STACK-SLEEVE FITTINGS

- A. Description: Manufactured, Dura-coated or Duco-coated cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

## 2.3 SLEEVE-SEAL SYSTEMS

- A. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20 psig (137 kPa) minimum.
3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
4. Pressure Plates: Carbon steel.
5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B633 of length required to secure pressure plates to sealing elements.

## 2.4 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.
- B. Plastic or rubber waterstop collar with center opening to match piping OD.

## 2.5 GROUT

- A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## 2.6 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, Use NT.
- B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant;

ASTM C920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.

- C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

### PART 3 - EXECUTION

#### 3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
    - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.
  - 2. Using grout or silicone sealant, seal space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
  - 2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
  - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

#### 3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
  - 1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
  - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
  - 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.
  - 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

5. Use silicone sealant to seal around the outside of stack-sleeve fittings.

- B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- or smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

### 3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

### 3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Use grout or silicone sealant, to seal the space around outside of sleeve-seal fittings.

### 3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.6 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
1. Exterior Concrete Walls above Grade:
    - a. Piping Smaller Than NPS 6 (DN 150): Cast-iron pipe sleeves.
    - b. Piping NPS 6 (DN 150) and Larger: Cast-iron pipe sleeves.
  2. Exterior Concrete Walls below Grade:

- a. Piping Smaller Than NPS 6 (DN 150): Cast-iron pipe sleeves with sleeve-seal system.
    - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
  - b. Piping NPS 6 (DN 150) and Larger: Cast-iron pipe sleeves with sleeve-seal system.
    - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
3. Concrete Slabs-on-Grade:
- a. Piping Smaller Than NPS 6 (DN 150): Cast-iron pipe sleeves with sleeve-seal system.
    - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
  - b. Piping NPS 6 (DN 150) and Larger: Cast-iron pipe sleeves with sleeve-seal system.
    - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
4. Concrete Slabs above Grade:
- a. Piping Smaller Than NPS 6 (DN 150): Steel pipe sleeves.
  - b. Piping NPS 6 (DN 150) and Larger: Steel pipe sleeves.
5. Interior Partitions:
- a. Piping Smaller Than NPS 6 (DN 150): Steel pipe sleeves.
  - b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel sheet sleeves.

END OF SECTION 21 05 17

## SECTION 21 05 18

### ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section Includes:
  - 1. Escutcheons.
  - 2. Floor plates.

##### 1.4 DEFINITIONS

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

##### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### PART 2 - PRODUCTS

##### 2.1 ESCUTCHEONS

- A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.
- C. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- D. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.

- E. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
- F. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

## 2.2 FLOOR PLATES

- A. Split Floor Plates: Steel with concealed hinge.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
  - 1. Escutcheons for New Piping:
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
    - b. Chrome-Plated Piping: One-piece steel with polished, chrome-plated finish.
    - c. Insulated Piping: One-piece steel with polished, chrome-plated finish.
    - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
    - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
    - f. Bare Piping in Unfinished Service Spaces: One-piece steel with polished, chrome-plated finish.
    - g. Bare Piping in Equipment Rooms: One-piece steel with polished, chrome-plated finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
  - 1. New Piping: One-piece, floor plate.

### 3.2 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 21 05 18

## SECTION 21 05 23

### GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Two-piece ball valves with indicators.
  - 2. Bronze butterfly valves with indicators.
  - 3. Iron butterfly valves with indicators.
  - 4. Check valves.
  - 5. Bronze OS&Y gate valves.
  - 6. Iron OS&Y gate valves.
  - 7. NRS gate valves.
  - 8. Indicator posts.
  - 9. Trim and drain valves.

##### 1.3 DEFINITIONS

- A. NRS: Nonrising stem.
- B. OS&Y: Outside screw and yoke.
- C. SBR: Styrene-butadiene rubber.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve.

##### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads, flange faces, and weld ends.
  - 3. Set valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:



1. Maintain valve end protection.
  2. Store valves indoors and maintain at higher-than-ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.
- D. Protect flanges and specialties from moisture and dirt.

## PART 2 - PRODUCTS

### 2.1 SOURCE LIMITATIONS

- A. Obtain each type of valve from single manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:
1. Fire Main Equipment: HAMV - Main Level.
    - a. Indicator Posts, Gate Valve: HCBZ - Level 1.
    - b. Ball Valves, System Control: HLUG - Level 3.
    - c. Butterfly Valves: HLXS - Level 3.
    - d. Check Valves: HMER - Level 3.
    - e. Gate Valves: HMRZ - Level 3.
  2. Sprinkler System and Water Spray System Devices: VDGT - Main Level.
    - a. Valves, Trim and Drain: VQGU - Level 1.
- B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:
1. Automated Sprinkler Systems:
    - a. Indicator posts.
    - b. Valves.
      - 1) Gate valves.
      - 2) Check valves
      - 3) Miscellaneous valves.
- C. ASME Compliance:
1. ASME B1.20.1 for threads for threaded-end valves.
  2. ASME B16.1 for flanges on iron valves.
  3. ASME B31.9 for building services piping valves.
- D. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

- E. NFPA Compliance for valves:
  - 1. Comply with NFPA 13, NFPA 14, NFPA 20, and NFPA 24.
- F. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher, as required by system pressures.
- G. Valve Sizes: Same as upstream piping unless otherwise indicated.
- H. Valve Actuator Types:
  - 1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
  - 2. Handwheel: For other than quarter-turn trim and drain valves.
  - 3. Handlever: For quarter-turn trim and drain valves NPS 2 (DN 50) and smaller.

### 2.3 TWO-PIECE BALL VALVES WITH INDICATORS

- A. Description:
  - 1. UL 1091, except with ball instead of disc and FM Global approved for indicating valves (butterfly or ball type), Class Number 1112.
  - 2. Minimum Pressure Rating: 175 psig (1200 kPa).
  - 3. Body Design: Two piece.
  - 4. Body Material: Forged brass or bronze.
  - 5. Port Size: Full or standard.
  - 6. Seats: PTFE.
  - 7. Stem: Bronze or stainless steel.
  - 8. Ball: Chrome-plated brass.
  - 9. Actuator: Worm gear
  - 10. Supervisory Switch: Internal or external.
  - 11. End Connections for Valves NPS 1 (DN 25) through NPS 2 (DN 50): Threaded ends.
  - 12. End Connections for Valves NPS 2-1/2 (DN 65): Grooved ends.

### 2.4 BRONZE BUTTERFLY VALVES WITH INDICATORS

- A. Description:
  - 1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 1112.
  - 2. Minimum: Pressure rating: 175 psig (1200 kPa).
  - 3. Body Material: Bronze.
  - 4. Seat Material: EPDM.
  - 5. Stem Material: Bronze or stainless steel.
  - 6. Disc: Stainless steel with EPDM coating.
  - 7. Actuator: Worm gear.
  - 8. Supervisory Switch: Internal or external.
  - 9. Ends Connections for Valves NPS 1 (DN 25) through NPS 2 (DN 50): Threaded ends.
  - 10. Ends Connections for Valves NPS 2-1/2 (DN 65): Grooved ends.

## 2.5 IRON BUTTERFLY VALVES WITH INDICATORS

### A. Description:

1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
2. Minimum Pressure Rating: 175 psig (1200 kPa).
3. Body Material: Cast or ductile iron.
4. Seat Material: EPDM.
5. Stem: Stainless steel.
6. Disc: Ductile iron, nickel plated and EPDM coated.
7. Actuator: Worm gear.
8. Supervisory Switch: Internal or external.
9. Body Design: Lug or wafer.

## 2.6 CHECK VALVES

### A. Description:

1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
2. Minimum Pressure Rating: 175 psig (1200 kPa).
3. Type: Single swing check.
4. Body Material: Cast iron, ductile iron, or bronze.
5. Clapper: Bronze, ductile iron, or stainless steel with elastomeric seal.
6. Clapper Seat: Brass, bronze, or stainless steel.
7. Hinge Shaft: Bronze or stainless steel.
8. Hinge Spring: Stainless steel.
9. End Connections: Flanged, grooved, or threaded.

## 2.7 BRONZE OS&Y GATE VALVES

### A. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig (1200 kPa).
3. Body and Bonnet Material: Bronze or brass.
4. Wedge: One-piece bronze or brass.
5. Wedge Seat: Bronze.
6. Stem: Bronze or brass.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Threaded.

## 2.8 IRON OS&Y GATE VALVES

### A. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig (1200 kPa).
3. Body and Bonnet Material: Cast or ductile iron.

4. Wedge: Cast or ductile iron, or bronze with elastomeric coating.
5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Flanged.

## 2.9 NRS GATE VALVES

### A. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig (1200 kPa).
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron with elastomeric coating.
5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Flanged.

## 2.10 INDICATOR POSTS

### A. Description:

1. Standard: UL 789 and FM Global standard for indicator posts.
2. Type: Wall.
3. Base Barrel Material: Cast or ductile iron.
4. Extension Barrel: Cast or ductile iron.
5. Cap: Cast or ductile iron.
6. Operation: Handwheel.

## 2.11 TRIM AND DRAIN VALVES

### A. Ball Valves:

1. Description:
  - a. Pressure Rating: 175 psig (1200 kPa).
  - b. Body Design: Two piece.
  - c. Body Material: Forged brass or bronze.
  - d. Port size: Full or standard.
  - e. Seats: PTFE.
  - f. Stem: Bronze or stainless steel.
  - g. Ball: Chrome-plated brass.
  - h. Actuator: Handlever.
  - i. End Connections for Valves NPS 1 (DN 25) through NPS 2-1/2 (DN 65): Threaded ends.
  - j. End Connections for Valves NPS 1-1/4 and NPS 2-1/2 (DN 32 and DN 65): Grooved ends.

### B. Angle Valves:

1. Description:
  - a. Pressure Rating: 175 psig (1200 kPa).
  - b. Body Material: Brass or bronze.
  - c. Ends: Threaded.
  - d. Stem: Bronze.
  - e. Disc: Bronze.
  - f. Packing: Asbestos free.
  - g. Handwheel: Malleable iron, bronze, or aluminum.

C. Globe Valves:

1. Description:
  - a. Pressure Rating: 175 psig (1200 kPa).
  - b. Body Material: Bronze with integral seat and screw-in bonnet.
  - c. Ends: Threaded.
  - d. Stem: Bronze.
  - e. Disc Holder and Nut: Bronze.
  - f. Disc Seat: Nitrile.
  - g. Packing: Asbestos free.
  - h. Handwheel: Malleable iron, bronze, or aluminum.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

### 3.2 INSTALLATION, GENERAL

- A. Comply with requirements in the following Sections for specific valve-installation requirements and applications:
  1. Section 211200 "Fire-Suppression Standpipes" for application of valves in fire-suppression standpipes.
  2. Section 211313 "Wet-Pipe Sprinkler Systems" for application of valves in wet-pipe, fire-suppression sprinkler systems.
  3. Section 211316 "Dry-Pipe Sprinkler Systems" for application of valves in dry-pipe, fire-suppression sprinkler systems.

- B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply, except from fire-department connections. Install permanent identification signs, indicating portion of system controlled by each valve.
- C. Install double-check valve assembly in each fire-protection water-supply connection.
- D. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.
- E. Install valves in horizontal piping with stem at or above the pipe center.
- F. Install valves in position to allow full stem movement.
- G. Install valve tags. Comply with requirements in Section 210553 "Identification for Fire-Suppression Piping and Equipment" for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.

END OF SECTION 21 05 23

## SECTION 21 05 29

### HANGERS AND SUPPORTS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

###### A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal hanger-shield inserts.
5. Fastener systems.
6. Equipment supports.

###### B. Related Requirements:

1. Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" for vibration isolation devices and seismic restraints.

##### 1.4 ACTION SUBMITTALS

###### A. Product Data: For each type of product.

- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Equipment supports.

- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Include design calculations for designing trapeze hangers.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

## 1.6 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.
- B. Structural Performance: Hangers and supports for fire-suppression piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
  - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
  - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
  - 3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.
- C. NFPA Compliance: Comply with NFPA 13.
- D. UL Compliance: Comply with UL 203.

### 2.2 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
  - 1. Description: Factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
  - 2. Galvanized Metallic Coatings: Pregalvanized or hot-dip galvanized.
  - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Copper Pipe and Tube Hangers:
  - 1. Description: Copper-coated-steel, factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
  - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.



## 2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with NFPA-approved, UL-listed, or FM-approved carbon-steel hanger rods, nuts, saddles, and U-bolts.

## 2.4 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
  - 1. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
  - 2. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
  - 3. Channels: Continuous slotted carbon-steel channel with inturned lips.
  - 4. Channel Width: Selected for applicable load criteria.
  - 5. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
  - 6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
  - 7. Metallic Coating: No coating.
  - 8. Paint Coating: Green epoxy, acrylic, or urethane.
- B. Non-MFMA Manufacturer Metal Framing Systems:
  - 1. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
  - 2. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
  - 3. Channels: Continuous slotted carbon-steel channel with inturned lips.
  - 4. Channel Width: Select for applicable load criteria.
  - 5. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
  - 6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
  - 7. Metallic Coating: No coating.
  - 8. Paint Coating: Green epoxy, acrylic, or urethane.

## 2.5 THERMAL HANGER-SHIELD INSERTS

- A. Insulation-Insert Material: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psi (688-kPa) minimum compressive strength.
- B. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- C. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- D. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

## 2.6 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: NFPA-approved, UL-listed, or FM-approved threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

- B. Mechanical-Expansion Anchors: NFPA-approved, UL-listed, or FM-approved, insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
  - 1. Indoor Applications: Zinc-coated steel.
  - 2. Outdoor Applications: Stainless steel.

## 2.7 EQUIPMENT SUPPORTS

- A. Description: NFPA-approved, UL-listed, or FM-approved, welded, shop- or field-fabricated equipment support, made from structural-carbon-steel shapes.

## 2.8 MATERIALS

- A. Aluminum: ASTM B221 (ASTM B221M).
- B. Carbon Steel: ASTM A1011/A1011M.
- C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.
- D. Stainless Steel: ASTM A240/A240M.
- E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout, suitable for interior and exterior applications.
  - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
  - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

## PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

### 3.2 INSTALLATION OF HANGERS AND SUPPORTS

- A. Metal Pipe-Hanger Installation: Comply with installation requirements of approvals and listings. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
  2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal strut systems.
- D. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Install in accordance with approvals and listings.
  2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Install in accordance with approvals and listings.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.
- K. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- M. Insulated Piping:
1. Attach clamps and spacers to piping.
    - a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
    - b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
    - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
  - a. MSS SP-58, Type 39 Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
  - a. MSS SP-58, Type 40 Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
  - a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
  - b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
  - c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
  - d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
  - e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

### 3.3 INSTALLATION OF EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment, and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

### 3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
  1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

### 3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

### 3.6 PAINTING

- A. Touchup:
  1. Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
    - a. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).
  2. Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Section 099113 "Exterior Painting." And Section 099123 "Interior Painting."
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

### 3.7 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with NFPA requirements for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- H. Use thermal hanger-shield inserts for insulated piping and tubing.

- I. Horizontal-Piping Hangers and Supports: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
  2. Steel Pipe Clamps (MSS Type 4): For suspension of NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
  3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
  4. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
  5. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
  6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
  7. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
  8. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
  9. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
  2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.
- K. Hanger-Rod Attachments: Comply with NFPA requirements.
- L. Building Attachments: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. C-Clamps (MSS Type 23): For structural shapes.
  3. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
- M. Saddles and Shields: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.
- N. Comply with NFPA requirements for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

- O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 21 05 29

## SECTION 21 05 48

### VIBRATION AND SEISMIC CONTROLS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

###### A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Elastomeric hangers.
5. Snubbers.
6. Restraints - rigid type.
7. Restraints - cable type.
8. Restraint accessories.
9. Post-installed concrete anchors.
10. Concrete inserts.

###### B. Related Requirements:

1. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for devices for plumbing equipment and systems.
2. Section 230548 "Vibration and Seismic Controls for HVAC" for devices for HVAC equipment and systems.

##### 1.3 DEFINITIONS

- A. Designated Seismic System: A fire-suppression component that requires design in accordance with ASCE/SEI 7, Ch. 13 and for which the Component Importance Factor is greater than 1.0.
- B. IBC: International Building Code.
- C. OSHPD: Office of Statewide Health Planning and Development (for the State of California).

##### 1.4 ACTION SUBMITTALS

###### A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.



2. Include load rating for each wind-load-restraint fitting and assembly.
3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component.
4. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by an agency acceptable to authorities having jurisdiction.
5. Annotate to indicate application of each product submitted and compliance with requirements.
6. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittal:

1. For each seismic-restraint device that is required by this Section or is indicated on Drawings, submit the following:
  - a. Seismic-Restraint Selection: Select seismic restraints complying with performance requirements, design criteria, and analysis data.
  - b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and seismic loads. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.
  - c. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated seismic loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
  - d. Seismic Design Calculations: Submit all input data and loading calculations prepared under "Seismic Design Calculations" Paragraph in "Performance Requirements" Article.
  - e. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared under "Wind-Load Design Calculations" in "Performance Requirements" Article.
  - f. Qualified Professional Engineer: All designated-design submittals for seismic calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.
2. Seismic-Restraint Detail Drawing:
  - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
  - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
  - c. Coordinate seismic restraint details with wind-load restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.

3. Product Listing, Preapproval, and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
  4. All delegated design submittals for seismic-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.
- D. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of seismic bracing for fire-suppression piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For professional engineer.
- C. Welding certificates.
- D. Field quality-control reports.
- E. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in ASCE/SEI 7-05, ASCE/SEI 7-10, ASCE/SEI 7-16, Paragraph 13.2.2, "Special Certification Requirements for Designated Seismic Systems" for all Designated Seismic Systems identified as such on Drawings or in the Specifications.
1. Provide equipment manufacturer's written certification for each designated active fire-suppression system seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7 and AHRI 1270 (AHRI 1271), including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction.
  2. Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7-05 ASCE/SEI 7-10, ASCE/SEI 7-16.
  3. Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed professional engineer.
- F. Wind-Load Performance Certification: Provide special certification for fire-suppression system components subject to high-wind exposure and impact damage and designated on Drawings or in the Specifications to require wind-load performance certification.
1. Provide equipment manufacturer's written certification for each designated fire-suppression system device, stating that it will remain in place and operable following the design wind event and comply with all requirements of authorities having jurisdiction.
  2. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.

## 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: an agency acceptable to authorities having jurisdiction.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic control system.
  - 1. Seismic Performance: Equipment must be designed and secured to withstand the effects of earthquake motions determined in accordance with NFPA 13 and ASCE/SEI 7-05, ASCE/SEI 7-10, ASCE/SEI 7-16.
- B. Seismic Design Calculations:
  - 1. Perform calculations to obtain force information necessary to properly select seismic-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in NFPA 13 or other seismic calculation method required by authorities having jurisdiction. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is the edition intended as reference throughout the Section Text.
    - a. Data indicated below to be determined by Delegated Design Contractor must be obtained by Contractor and must be included in individual component submittal packages.
    - b. Building Occupancy Category: III.
    - c. Building Risk Category: II.
    - d. Building Site Classification: D.
  - 2. Calculation Factors, ASCE/SEI 7-16, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-16 unless otherwise noted.
    - a. Horizontal Seismic Design Force  $F_p$ : Value is to be calculated by Delegated Design Contractor using Equation 13.3-1. Factors below must be obtained for this calculation:
      - 1)  $S_{DS}$  = Spectral Acceleration. Value applies to all components on Project.
      - 2)  $a_p$  = Component Amplification Factor: See Drawing Schedule for each component.

- 3)  $I_p$  = Component Importance Factor: See Drawing Schedule for each component.
  - 4)  $W_p$  = Component Operating Weight: For each component. Obtain by Delegated Design Contractor from each component submittal.
  - 5)  $R_p$  = Component Response Modification Factor: See Drawing Schedule for each component.
  - 6)  $z$  = Height in Structure of Point of Attachment of Component for Base: Determine from Project Drawings for each component by Delegated Design Contractor. For items at or below the base, "z" is to be taken as zero.
  - 7)  $h$  = Average Roof Height of Structure for Base: Determine from Project Drawings by Delegated Design Contractor.
- b. Vertical Seismic Design Force: Calculated by Delegated Design Contractor using method explained in ASCE/SEI 7-16, Paragraph 13.3.1.2.
- c. Seismic Relative Displacement  $D_{pl}$ : Calculated by Delegated Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.2. Factors below must be obtained for this calculation:
- 1)  $D_p$  = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculated by Delegated Design Contractor in accordance with ASCE/SEI 7-16, Paragraph 13.3.2.
  - 2)  $I_e$  = Structure Importance Factor: Value applies to all components on Project.
  - 3)  $\delta_{xA}$  = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
  - 4)  $\delta_{yA}$  = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.
  - 5)  $\delta_{yB}$  = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
  - 6)  $h_x$  = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
  - 7)  $h_y$  = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
  - 8)  $\Delta_{aA}$  = Allowable Story Drift for Structure A: See Drawing Schedules for each component.
  - 9)  $\Delta_{aB}$  = Allowable Story Drift for Structure B: See Drawing Schedules for each component.
  - 10)  $h_{sx}$  = Story Height Used in the Definition of the Allowable Drift  $\Delta_a$ : See Drawings Schedules for each component.
- d. Component Fundamental Period  $T_p$ : Calculated by Delegated Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.3. Factors below must be obtained for this calculation:
- 1)  $W_p$  = Component Operating Weight: Determined by contractor from Project Drawings and manufacturer's data.
  - 2)  $g$  = Gravitational Acceleration: 32.17 fps<sup>2</sup> (9.81 m/s<sup>2</sup>).
  - 3)  $K_p$  = Combined Stiffness of Component, Supports, and Attachments: Determined by delegated design seismic engineer.
3. Calculation Factors, ASCE/SEI 7-10, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-10 unless otherwise noted.

- a. Horizontal Seismic Design Force  $F_p$ : Calculated by Delegated Design Contractor by ASCE/SEI 7-10, Equation 13.3-1. Factors below must be obtained for this calculation:
    - 1)  $S_{DS}$  = Spectral Acceleration. Value applies to all components on Project.
    - 2)  $a_p$  = Component Amplification Factor: See Drawing Schedule for each component.
    - 3)  $I_p$  = Component Importance Factor: See Drawing Schedule for each component.
    - 4)  $W_p$  = Component Operating Weight: For each component. Obtain by Delegated Design Contractor from equipment submittal.
    - 5)  $R_p$  = Component Response Modification Factor: See Drawing Schedule for each component.
    - 6)  $z$  = Height in Structure of Point of Attachment of Component for Base: Determined from Project Drawings for each component by Contractor. For items at or below the base, "z" is to be taken as zero.
    - 7)  $h$  = Average Roof Height of Structure for Base: Determine from Project Drawings by Delegated Design Contractor.
  - b. Vertical Seismic Design Force: Calculate by Delegated Design Contractor using method explained in ASCE/SEI 7-10, Paragraph 13.3.1.
  - c. Seismic Relative Displacement  $D_p$ : Calculate by Delegated Design Contractor using methods explained in ASCE/SEI 7-10, Paragraph 13.3.2. Factors below must be obtained for this calculation:
    - 1)  $D_p$  = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculate by Delegated Design Contractor in accordance with ASCE/SEI 7-10, Paragraph 13.3.2.
    - 2)  $I_e$  = Structure Importance Factor: Value applies to all components on Project.
    - 3)  $\delta_{xA}$  = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
    - 4)  $\delta_{yA}$  = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.
    - 5)  $\delta_{yB}$  = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
    - 6)  $h_x$  = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
    - 7)  $h_y$  = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
    - 8)  $\Delta_{aA}$  = Allowable Story Drift for Structure A: See Drawing Schedule for each component.
    - 9)  $\Delta_{aB}$  = Allowable Story Drift for Structure B: See Drawing Schedule for each component.
    - 10)  $h_{sx}$  = Story Height Used in the Definition of the Allowable Drift  $\Delta_a$ : See Drawing Schedule for each component.
4. Calculation Factors, ASCE/SEI 7-05, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-05 unless otherwise noted.
- a. Horizontal Seismic Design Force  $F_p$ : Calculated by Delegated Design Contractor by ASCE/SEI 7-05, Equation 13.3-1. Factors below must be obtained for this calculation:

- 1)  $S_{DS}$  = Spectral Acceleration: Value applies to all components on Project.
  - 2)  $a_p$  = Component Amplification Factor: See Drawing Schedule for each component.
  - 3)  $I_p$  = Component Importance Factor: See Drawing Schedule for each component.
  - 4)  $W_p$  = Component Operating Weight: Obtain by Delegated Design Contractor for each component from component submittal.
  - 5)  $R_p$  = Component Response Modification Factor: See Drawing Schedule for each component.
  - 6)  $z$  = Height in Structure of Point of Attachment of Component for Base: Determine by Delegated Design Contractor for each component from Project Drawings. For items at or below the base, "z" is to be taken as zero.
  - 7)  $h$  = Average Roof Height of Structure for Base: Determine by Delegated Design Contractor from Project Drawings.
- b. Vertical Seismic Design Force: Calculated by Delegated Design Contractor using method explained in ASCE/SEI 7-05, Paragraph 13.3.1.
- c. Seismic Relative Displacement  $D_p$ : Calculated by Delegated Design Contractor using methods explained in ASCE/SEI 7-05, Paragraph 13.3.2. Factors below must be obtained for this calculation:
- 1)  $\delta_{xA}$  = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
  - 2)  $\delta_{yA}$  = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.
  - 3)  $\delta_{yB}$  = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
  - 4)  $h_x$  = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
  - 5)  $h_y$  = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
  - 6)  $\Delta_{aA}$  = Allowable Story Drift for Structure A: See Drawing Schedule for each component.
  - 7)  $\Delta_{aB}$  = Allowable Story Drift for Structure B: See Drawing Schedule for each component.
  - 8)  $h_{sx}$  = Story Height Used in the Definition of the Allowable Drift  $\Delta_a$ : See Drawing Schedule for each component.

C. Wind-Load Design Calculations:

1. Perform calculations to obtain force information necessary to properly select wind-load-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7-05 edition or other wind-load calculation method required by authorities having jurisdiction. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is intended as referenced throughout the Section Text unless otherwise noted.
  - a. Factors indicated below that are specific to individual pieces of equipment must be obtained by Contractor and must be included in individual component submittal packages.
  - b. Coordinate design wind-load calculations with seismic load calculations for equipment requiring both seismic and wind-load reinforcement. Comply with

requirements in other Sections in addition to those in this Section for equipment mounted outdoors.

2. Design wind pressure "p" for external sidewall-mounted equipment is to be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-16, Ch. 30. Perform calculations in accordance with one of the following, as appropriate:
  - a. PART 1: Low-Rise Buildings.
  - b. PART 2: Low-Rise Buildings (Simplified).
  - c. PART 3: Buildings with "h" less than 60 feet (18.3 m).
  - d. PART 4: Buildings with "h" greater than 60 feet (18.3 m) and less than 160 feet (48.8 m).
  - e. PART 5: Open Buildings.
  - f. Risk Category: II.
  - g.  $h$  = Mean Roof Height:
  - h.  $V$  = Basic Wind Speed:
  - i.  $K_d$  = Wind Directionality Factor:
  - j. Exposure Category:
  - k.  $K_{zt}$  = Topographic Factor:
  - l.  $K_e$  = Ground Elevation Factor:
  - m.  $K_z$  = Velocity Pressure Exposure Coefficient (Evaluated at Height  $z$ ):
  - n.  $K_h$  = Velocity Pressure Exposure Coefficient (Evaluated at Height  $h$ ):
  - o.  $q_z$  = Velocity Pressure: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-16 Section 26.10.1 or other source approved by authorities having jurisdiction.
  - p.  $q_h$  = Velocity Pressure: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-16 Section 26.10.1 or other source approved by authorities having jurisdiction.
  - q.  $G$  = Gust-Effect Factor: 0.85.
  - r. Enclosure Classification:
  - s.  $GC_{pi}$  = Internal Pressure Coefficient:
  
3. Design wind pressure "p" for external sidewall-mounted equipment is to be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-10, Ch. 30. Perform calculations in accordance with the following, as appropriate:
  - a. PART 1: Low-Rise Buildings.
  - b. PART 2: Low-Rise Buildings (Simplified).
  - c. PART 3: Buildings with "h" greater than 60 feet (18.3 m).
  - d. PART 4: Buildings with "h" less than 160 feet (48.8 m).
  - e. PART 5: Open Buildings.
  - f. Risk Category: II.
  - g.  $h$  = Mean Roof Height:
  - h.  $V$  = Basic Wind Speed:
  - i.  $K_d$  = Wind Directionality Factor:
  - j. Exposure Category:
  - k.  $K_{zt}$  = Topographic Factor:
  - l.  $K_z$  = Velocity Pressure Exposure Coefficient (Evaluated at Height  $z$ ):
  - m.  $K_h$  = Velocity Pressure Exposure Coefficient (Evaluated at Height  $h$ ):
  - n.  $q_z$  = Velocity Pressure at Height  $z$ : Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-10 Section 26.10.1 or other source approved by authorities having jurisdiction.

- o.  $q_h$  = Velocity Pressure at Height h: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-10 Section 26.10.1 or other source approved by authorities having jurisdiction.
  - p.  $G$  = Gust-Effect Factor: 0.85.
  - q. Enclosure Classification:
  - r.  $GC_{pi}$  = Internal Pressure Coefficient:
4. Design wind force "F" for rooftop equipment and external sidewall-mounted equipment such as louvers is to be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-05, Ch. 6.
- a.  $I$  = Importance Factor:
  - b.  $h$  = Mean Roof Height:
  - c.  $V$  = Basic Wind Speed:
  - d.  $K_d$  = Wind Directionality Factor:
  - e. Exposure Category:
  - f.  $K_{zt}$  = Topographic Factor:
  - g.  $K_z$  = Velocity Pressure Exposure Coefficient (Evaluated at Height z):
  - h.  $K_h$  = Velocity Pressure Exposure Coefficient (Evaluated at Height h):
  - i.  $q_z$  = Velocity Pressure at Height z: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-05 Section 6.5.10 or other source approved by authorities having jurisdiction.
  - j.  $q_h$  = Velocity Pressure at Roof Height h: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-05 Section 6.5.10 or other source approved by authorities having jurisdiction.
  - k.  $G$  = Gust-Effect Factor: 0.85.
  - l.  $GC_{pi}$  = Internal Pressure Coefficient:
  - m.  $GC_p$  = External Pressure Coefficient:
  - n.  $C_f$  = Force Coefficient: Value determined by delegated wind-load design Contractor from ASCE/SEI 7-05, Figures 6-21 through 6-23 or other source approved by authorities having jurisdiction.
  - o.  $A_f$  = Projected Area Normal to the Wind: Except where  $C_f$  is specified for the actual surface area, value determined by delegated wind-load design Contractor from equipment submittal or manufacturer.
- D. Consequential Damage: Provide additional seismic and wind-load restraints for suspended fire-suppression system components or anchorage of floor-, roof-, or wall-mounted fire-suppression system components as indicated in ASCE/SEI 7-05 so that failure of a non-essential or essential fire-suppression system component will not cause the failure of any other essential architectural, mechanical, or electrical building component.
- E. Fire/Smoke Resistance: Seismic-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.
- F. Component Supports:
- 1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.
  - 2. All component support attachments must comply with force and displacement resistance requirements of ASCE/SEI 7-05 Section 13.6.



## 2.2 ELASTOMERIC ISOLATION PADS

### A. Elastomeric Isolation Pads:

1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
2. Size: Factory or field cut to match requirements of supported equipment.
3. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
4. Surface Pattern: Smooth, ribbed, or waffle pattern.
5. Infused nonwoven cotton or synthetic fibers.
6. Load-bearing metal plates adhered to pads.
7. Sandwich-Core Material: Resilient
  - a. Surface Pattern: Smooth, ribbed, or waffle pattern.
  - b. Infused nonwoven cotton or synthetic fibers.

## 2.3 ELASTOMERIC ISOLATION MOUNTS

### A. Double-Deflection, Elastomeric Isolation Mounts:

1. Mounting Plates:
  - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded.
  - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
2. Elastomeric Material: Molded, oil- and water-resistant neoprene rubber, silicone rubber, or other elastomeric material.

## 2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

### A. Restrained Elastomeric Isolation Mounts:

1. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
  - a. Housing: Cast-ductile iron or welded steel.
  - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.5 ELASTOMERIC HANGERS

### A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:

1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
2. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel-to-steel contact.

## 2.6 SNUBBERS

- A. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with ACI 318-14 Ch. 17 for 2015 IBC.
  2. Preset Concrete Inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
  3. Anchors in Masonry: Design in accordance with TMS 402.
  4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
  5. Resilient Cushion: Maximum 1/4-inch (6-mm) air gap, and minimum 1/4 inch (6 mm) thick.

## 2.7 RESTRAINTS - RIGID TYPE

- A. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

## 2.8 RESTRAINTS - CABLE TYPE

- A. Seismic-Restraint Cables: ASTM A1023/A12023M galvanized or ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.
- B. Restraint cable assembly with cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

## 2.9 RESTRAINT ACCESSORIES

- A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Non-metallic stiffeners are unacceptable.
- B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid restraints.
- C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

## 2.10 POST-INSTALLED CONCRETE ANCHORS

- A. Mechanical Anchor Bolts:
  - 1. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.
- B. Adhesive Anchor Bolts:
  - 1. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.
- C. Provide post-installed concrete anchors that have been prequalified for use in seismic applications. Post-installed concrete anchors must comply with all requirements of ASCE/SEI 7-05, Ch. 13.
  - 1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
  - 2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.
- D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp (7.46 kW) that is not vibration isolated.
  - 1. Undercut expansion anchors are permitted.

## 2.11 CONCRETE INSERTS

- A. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC466 testing.
- B. Comply with ANSI/MSS SP-58.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry calculated static and seismic loads within specified loading limits.

### 3.3 INSTALLATION OF VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICES

- A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Fire-Suppression Vibration Isolation, Seismic, and Wind-Load-Restraint Schedule, where indicated on Drawings, or where the Specifications indicate they are to be installed on specific equipment and systems.
- B. Provide seismic-restraint devices for systems and equipment where indicated in Equipment Schedules or Vibration Isolation, Seismic, and Wind-Load-Restraint Schedules, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.
- C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- D. Installation of vibration isolators and seismic restraints must not cause any stresses, misalignment, or change of position of equipment or piping.
- E. Comply with installation requirements of NFPA 13 for installation of all seismic-restraint devices.
- F. Comply with requirements in Section 077200 "Roof Accessories" for installation of equipment supports and roof penetrations.
- G. Equipment Restraints:
  - 1. Install snubbers on fire-suppression equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
  - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
  - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- H. Piping Restraints:
  - 1. Comply with all requirements in NFPA 13.
  - 2. Design piping sway bracing in accordance with NFPA 13.
    - a. Maximum spacing of all sway bracing to be no greater than indicated in NFPA 13.
    - b. Design loading of all sway bracing not to exceed values indicated in NFPA 13.

- I. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- J. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- K. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- L. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- M. Post-Installed Concrete Anchors:
  - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
  - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
  - 3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors to be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
  - 4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
  - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
  - 6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

### 3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross structural seismic joints and other points where differential movement may occur, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 211200 "Fire-Suppression Standpipes," Section 211313 "Wet-Pipe Sprinkler Systems," and Section 211316 "Dry-Pipe Sprinkler Systems" for piping flexible connections.

### 3.5 ADJUSTING

- A. Adjust isolators after system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

### 3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Tests and Inspections:
  - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
  - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
  - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  - 4. Test at no fewer than four of each type and size of installed anchors and fasteners selected by Architect.
  - 5. Test to 90 percent of rated proof load of device.
  - 6. Measure isolator restraint clearance.
  - 7. Measure isolator deflection.
  - 8. Verify snubber minimum clearances.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Units will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 21 05 48

## SECTION 21 05 53

### IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Warning signs and labels.
  - 3. Warning tape
  - 4. Pipe labels.
  - 5. Stencils.
  - 6. Valve tags.
  - 7. Warning tags.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment-Label Schedule: Include a listing of all equipment to be labeled and the proposed content for each label.
- D. Valve-numbering scheme.
- E. Valve Schedules: Provide for fire-suppression piping system. Include in operation and maintenance manuals.

#### PART 2 - PRODUCTS

##### 2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
  - 1. Material and Thickness: Brass, 0.032 inch (0.8 mm) thick, with predrilled or stamped holes for attachment hardware.
  - 2. Letter and Background Color: As indicated for specific application under Part 3.

3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
  4. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  5. Fasteners: Stainless steel rivets or self-tapping screws.
  6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, with predrilled holes for attachment hardware.
  2. Letter and Background Color: As indicated for specific application under Part 3.
  3. Maximum Temperature: Able to withstand temperatures of up to 160 deg F (71 deg C).
  4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
  5. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  6. Fasteners: Stainless steel rivets or self-tapping screws.
  7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

## 2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, with predrilled holes for attachment hardware.
- B. Letter and Background Color: As indicated for specific application under Part 3.
- C. Maximum Temperature: Able to withstand temperatures of up to 160 deg F (71 deg C).
- D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- E. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- F. Fasteners: Stainless steel rivets or self-tapping screws.
- G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- H. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.



## 2.3 WARNING TAPE

- A. Material: Vinyl.
- B. Minimum Thickness: 0.005 inch (0.12 mm).
- C. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.
- D. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.
- E. Maximum Temperature: 160 deg F (70 deg C).
- F. Minimum Width: 2 inches (50 mm).

## 2.4 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.
- B. Letter and Background Color: As indicated for specific application under Part 3.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include the following:
  - 1. Pipe size.
  - 2. Flow-Direction Arrows: Include flow-direction arrows on main distribution piping. Arrows may be either integral with label or applied separately.
  - 3. Lettering Size: Size letters in accordance with ASME A13.1 for piping.

## 2.5 STENCILS

- A. Stencils for Piping:
  - 1. Lettering Size: Size letters in accordance with ASME A13.1 for piping.
  - 2. Stencil Material: Aluminum, brass, or fiberboard.
  - 3. Stencil Paint: Exterior, gloss, alkyd enamel. Paint may be in pressurized spray-can form.
  - 4. Identification Paint: Exterior, alkyd enamel. Paint may be in pressurized spray-can form.
  - 5. Letter and Background Color: As indicated for specific application under Part 3.

## 2.6 VALVE TAGS

- A. Description: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping-system abbreviation and 1/2-inch (13-mm) numbers.
  - 1. Tag Material: Brass, 0.04 inch (1.0 mm) thick, with predrilled or stamped holes for attachment hardware.
  - 2. Fasteners: Brass wire.

- B. Letter and Background Color: As indicated for specific application under Part 3.
- C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
  - 1. Include valve-tag schedule in operation and maintenance data.

## 2.7 WARNING TAGS

- A. Description: Preprinted accident-prevention tags, of plasticized card stock.
  - 1. Size: 3 by 5-1/4 inches (75 by 133 mm) minimum.
  - 2. Fasteners: Brass grommet and wire.
  - 3. Nomenclature: Large-size primary caption, such as "DANGER," "CAUTION," or "DO NOT OPERATE."
  - 4. Letter and Background Color: As indicated for specific application under Part 3.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

### 3.2 INSTALLATION GENERAL REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be installed.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Locate identifying devices so that they are readily visible from the point of normal approach.

### 3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

- A. Permanently fasten labels on each item of fire-suppression equipment.
- B. Sign and Label Colors:
  - 1. White letters on an ANSI Z535.1 safety-red background.
- C. Locate equipment labels where accessible and visible.

- D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where arc-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E.

### 3.4 INSTALLATION OF WARNING TAPE

- A. Warning Tape Color and Pattern: Yellow background with black diagonal stripes.
- B. Install warning tape on pipes and ducts, with cross-designated walkways providing less than 6 ft. (2 m) of clearance.
- C. Locate tape so as to be readily visible from the point of normal approach.

### 3.5 INSTALLATION OF PIPE LABELS

- A. Piping Color Coding: Painting of piping is specified in Section 099123 "Interior Painting."
- B. Install pipe labels showing service and flow direction with permanent adhesive on pipes.
- C. Stenciled Pipe-Label Option: Stenciled labels showing service and flow direction may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1 on each piping system.
  - 1. Identification Paint: Use for contrasting background.
  - 2. Stencil Paint: Use for pipe marking.
- D. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  - 1. Within 3 ft. (1 m) of each valve and control device.
  - 2. At access doors, manholes, and similar access points that permit a view of concealed piping.
  - 3. Within 3 ft. (1 m) of equipment items and other points of origination and termination.
  - 4. Spaced at maximum intervals of 25 ft. (8 m) along each run. Reduce intervals to 10 ft. (3 m) in areas of congested piping and equipment.
- E. Flow- Direction Arrows: Provide arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- F. Fire-Suppression Pipe Label Color Schedule:
  - 1. Fire-Suppression Pipe Labels: White letters on an ANSI Z535.1 safety-red background.

### 3.6 INSTALLATION OF VALVE TAGS

- A. Install tags on valves and control devices in fire-suppression piping systems. List tagged valves in a valve-tag schedule in the operating and maintenance manual. Include the identification "FSV" on all fire-suppression system valve tags.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below.

1. Valve-Tag Size and Shape:
  - a. Fire-Suppression Standpipe: 1-1/2 inches (38 mm), round.
  - b. Wet-Pipe Sprinkler System: 1-1/2 inches (38 mm), round.
  - c. Dry-Pipe Sprinkler System: 1-1/2 inches (38 mm), round.
  - d. Clean-Agent Fire-Extinguishing System: 1-1/2 inches (38 mm), round.
  - e. Preaction System: 1-1/2 inches (38 mm), round.
2. Valve-Tag Color: White letters on an ANSI Z535.1 safety-red background.

### 3.7 INSTALLATION OF WARNING TAGS

- A. Warning Tag Color: Black letters on an ANSI Z535.1 safety-yellow background.
- B. Attach warning tags, with proper message, to equipment and other items where indicated on Drawings.

END OF SECTION 21 05 53

## SECTION 21 11 19

### FIRE DEPARTMENT CONNECTIONS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section Includes:
  - 1. Exposed-type fire-department connections.
  - 2. Flush-type fire-department connections.
  - 3. Yard-type fire-department connections.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each fire-department connection.

#### PART 2 - PRODUCTS

##### 2.1 EXPOSED-TYPE FIRE-DEPARTMENT CONNECTION

- A. Standard: UL 405.
- B. Type: Exposed, projecting, for wall mounting.
- C. Pressure Rating: 175 psig (1200 kPa) minimum.
- D. Body Material: Corrosion-resistant metal.
- E. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.

- F. Caps: Brass, lugged type, with gasket and chain.
- G. Escutcheon Plate: Round, brass, wall type.
- H. Outlet: Back, with pipe threads.
- I. Number of Inlets: Two.
- J. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE."
- K. Finish: Polished chrome plated.
- L. Outlet Size: NPS 4 (DN 100).

## 2.2 FLUSH-TYPE FIRE-DEPARTMENT CONNECTION

- A. Standard: UL 405.
- B. Type: Flush, for wall mounting.
- C. Pressure Rating: 175 psig (1200 kPa) minimum.
- D. Body Material: Corrosion-resistant metal.
- E. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
- F. Caps: Brass, lugged type, with gasket and chain.
- G. Escutcheon Plate: Rectangular, brass, wall type.
- H. Outlet: With pipe threads.
- I. Body Style: Horizontal.
- J. Number of Inlets: Two.
- K. Outlet Location: Bottom.

Retain first option in "Escutcheon Plate Marking" Paragraph below if standpipes supply a sprinkler system.

- L. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE."
- M. Finish: Polished chrome plated.
- N. Outlet Size: NPS 4 (DN 100).

## 2.3 YARD-TYPE FIRE-DEPARTMENT CONNECTION

- A. Standard: UL 405.

- B. Type: Exposed, freestanding.
- C. Pressure Rating: 175 psig (1200 kPa) minimum.
- D. Body Material: Corrosion-resistant metal.
- E. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
- F. Caps: Brass, lugged type, with gasket and chain.
- G. Escutcheon Plate: Round, brass, floor type.
- H. Outlet: Bottom, with pipe threads.
- I. Number of Inlets: Two.
- J. Sleeve: Brass.
- K. Sleeve Height: 18 inches (460 mm).
- L. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE."
- M. Finish, Including Sleeve: Polished chrome plated.
- N. Outlet Size: NPS 4 (DN 100).

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fire-department connections.
- B. Examine roughing-in for fire-suppression standpipe system to verify actual locations of piping connections before fire-department connection installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Install wall-type fire-department connections.
- B. Install yard-type fire-department connections in concrete slab support. Comply with requirements for concrete in Section 033000 "Cast-in-Place Concrete."
- C. Install two protective pipe bollards around each fire-department connection. Comply with requirements for bollards in Section 055000 "Metal Fabrications."
- D. Install automatic (ball-drip) drain valve at each check valve for fire-department connection.

END OF SECTION 21 11 19



## SECTION 21 12 00

### FIRE-SUPPRESSION STANDPIPES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection specialty valves.
3. Hose connections.
4. Alarm devices.
5. Manual control stations.
6. Control panels.
7. Pressure gauges.

B. Related Requirements:

1. Section 104413 "Fire Protection Cabinets" for hose-connection and hose-station cabinets.
2. Section 210523 "General-Duty Valves for Water-Based Fire-Suppression Piping."
3. Section 211119 "Fire Department Connections" for exposed-, flush-, and yard-type fire-department connections.
4. Section 211213 "Fire-Suppression Hoses and Nozzles" for rack-type hose stations, reel-type hose stations, and monitors.
5. Section 211313 "Wet-Pipe Sprinkler Systems" for wet-pipe sprinkler piping.
6. Section 211316 "Dry-Pipe Sprinkler Systems" for dry-pipe sprinkler piping.
7. Section 284621.11 "Addressable Fire-Alarm Systems" for connections to alarm devices.
8. Section 331415 "Site Water Distribution Piping" for water-service piping; ductile-iron expansion joints and deflection fittings; tubular- and split-sleeve, pipe-coupling transition fittings; water meters; detector check valves; backflow preventers; and protective enclosures.

##### 1.3 DEFINITIONS

- A. High-Pressure Standpipe Piping: Fire-suppression standpipe piping designed to operate at working pressure of higher than standard 175 psig (1200 kPa), but not higher than 250 psig (1725 kPa).
- B. Standard-Pressure Standpipe Piping: Fire-suppression standpipe piping designed to operate at maximum working pressure of 175 psig (1200 kPa).

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For fire-suppression standpipes.
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Include diagrams for power, signal, and control wiring.
- C. Delegated Design Submittal: For standpipe systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, sections, and other details, drawn to scale, or BIM model, showing the items described in this Section and coordinated with all building trades.
- B. Qualification Data: For Installer and professional engineer.
- C. Approved Standpipe Drawings: Working plans, prepared in accordance with NFPA 14, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- D. Welding certificates.
- E. Fire-hydrant flow test report.
- F. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 14. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."
- G. Field quality-control reports.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-suppression standpipes specialties to include in emergency, operation, and maintenance manuals.

#### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
  - 1. Installer's responsibilities include designing, fabricating, and installing fire-suppression standpipes and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
    - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

- B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

## PART 2 - PRODUCTS

### 2.1 SYSTEM DESCRIPTIONS

- A. Automatic Wet-Type, Class I Standpipe System: Includes NPS 2-1/2 (DN 65) hose connections, has open water-supply valve with pressure maintained, and is capable of supplying water demand.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Standards: Fire-suppression standpipe equipment, specialties, accessories, installation, and testing shall comply with NFPA 14.
- C. Standard-Pressure, Fire-Suppression Standpipe System Component: Listed for 175-psig (1200-kPa) minimum working pressure.
- D. High-Pressure, Fire-Suppression Standpipe System Component: Listed for 250-psig (1725-kPa) minimum working pressure.
- E. Delegated Design: Design fire-suppression standpipes, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- F. Fire-suppression standpipe design shall be approved by authorities having jurisdiction.
  - 1. Minimum residual pressure at each hose-connection outlet is as follows:
    - a. NPS 2-1/2 (DN 65) Hose Connections: 65 psig (450 kPa)].
- G. Seismic Performance: Fire-suppression standpipes shall withstand the effects of earthquake motions determined in accordance with NFPA 13 and ASCE/SEI 7. See Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."

### 2.3 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials and for joining methods for specific services, service locations, and pipe sizes.

### 2.4 BLACK STEEL PIPE AND ASSOCIATED FITTINGS

- A. Schedule 40: ASTM A53/A53M, Type E, Grade B, ASTM A135/A135M, Grade A, ASTM A795/A795M, Type E, Grade A, with factory- or field-formed ends to accommodate joining method.

- B. Schedule 30: ASTM A53/A53M, Type E, Grade B, ASTM A135/A135M, Grade A, ASTM A795/A795M, Type E, Grade A, with factory- or field-formed ends to accommodate joining method.
- C. Thinwall: ASTM A53/A53M, Type E, ASTM A135/A135M, Grade A, ASTM A795/A795M, Type E, Grade A, with wall thickness of less than Schedule 30 and equal to or greater than Schedule 10, and with factory- or field-formed ends to accommodate joining method.
- D. Schedule 10: ASTM A135/A135M or ASTM A795/A795M, Schedule 10 in NPS 5 (DN 125) and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10 (DN 150 to DN 250), plain end.
- E. Lightwall: ASTM A135/A135M, or ASTM A795/A795M, with wall thickness of less than Schedule 10 and greater than Schedule 5.
- F. Uncoated, Steel Couplings: ASTM A865/A865M, threaded.
- G. Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- H. Malleable- or Ductile-Iron Unions: UL 860.
- I. Cast-Iron Flanges: ASME B16.1, Class 125.
- J. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- K. Steel Welding Fittings: ASTM A234/A234M and ASME B16.9.
- L. Grooved-Joint, Steel-Pipe Appurtenances:
  1. Pressure Rating: 175-psig (1200-kPa) minimum.
  2. Galvanized, Grooved-End Fittings for Steel Piping: ASTM A47/A47M malleable-iron casting or ASTM A536 ductile-iron casting, with dimensions matching steel pipe.
  3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

## 2.5 COPPER TUBE AND ASSOCIATED FITTINGS

- A. Hard Copper Tube: ASTM B88, Type L (ASTM B88M, Type B) water tube, drawn temper.
- B. Cast-Copper, Solder-Joint Fittings: ASME B16.18 pressure fittings.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22 pressure fittings.
- D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- E. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- F. Grooved-Joint, Copper-Tube Appurtenances:
  1. Grooved-End, Copper Fittings: ASTM B75/B75M copper tube or ASTM B584 bronze castings.
  2. Grooved-End-Tube Couplings: To fit copper tube dimensions, with design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gasket suitable for hot and cold water, and bolts and nuts.

## 2.6 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110/A21.10, rubber, flat face, 1/8 inch (3.2 mm) thick.
  - 1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
  - 2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1 carbon steel unless otherwise indicated.
- C. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

## 2.7 SPECIALTY VALVES

- A. General Requirements:
  - 1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
  - 2. Pressure Rating:
    - a. Standard-Pressure Piping Specialty Valves: 175-psig (1200-kPa) minimum.
    - b. High-Pressure Piping Specialty Valves: 250-psig (1725-kPa) minimum.
  - 3. Body Material: Cast or ductile iron.
  - 4. Size: Same as connected piping.
  - 5. End Connections: Flanged or grooved.
- B. Alarm Valves:
  - 1. Standard: UL 193.
  - 2. Design: For horizontal or vertical installation.
  - 3. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gauges, retarding chamber, and fill-line attachment with strainer.
  - 4. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
- C. Deluge Valves:
  - 1. Standard: UL 260.
  - 2. Design: Hydraulically operated, differential-pressure type.
  - 3. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gauges, drip cup assembly piped without valves and separate from main drain line, fill-line attachment with strainer, and push-rod chamber supply connection.
  - 4. Wet, Pilot-Line Trim Set: Include gauge to read push-rod chamber pressure, globe valve for manual operation of deluge valve, and connection for actuation device.
- D. Pressure-Reducing Valves:
  - 1. UL 668 hose valve, with integral UL 1468 reducing device.
  - 2. Pressure Rating: 300-psig (2070-kPa) minimum.
  - 3. Material: Brass or bronze.
  - 4. Inlet: Female pipe threads.
  - 5. Outlet: Threaded with or without adapter having male hose threads.
  - 6. Pattern: Angle.

7. Finish: Polished chrome plated.

E. Automatic (Ball Drip) Drain Valves:

1. Standard: UL 1726.
2. Pressure Rating: 175-psig (1200-kPa) minimum.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4 (DN 20).
5. End Connections: Threaded.

## 2.8 HOSE CONNECTIONS

A. Adjustable-Valve Hose Connections:

1. Standard: UL 668 hose valve, with integral UL 1468 reducing or restricting pressure-control device, for connecting fire hose.
2. Pressure Rating: 300-psig (2070-kPa) minimum.
3. Material: Brass or bronze.
4. Size: NPS 1-1/2 or NPS 2-1/2 (DN 40 or DN 65), as indicated.
5. Inlet: Female pipe threads.
6. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads in accordance with NFPA 1963 and matching local fire-department threads.
7. Pattern: Angle.
8. Pressure-Control Device Type: Pressure reducing.
9. Design Outlet Pressure Setting: 65 psig (450 kPa).
10. Finish: Polished chrome plated.

B. Nonadjustable-Valve Hose Connections:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: UL 668 hose valve for connecting fire hose.
3. Pressure Rating: 300-psig (2070-kPa) minimum.
4. Material: Brass or bronze.
5. Size: NPS 1-1/2 or NPS 2-1/2 (DN 40 or DN 65), as indicated.
6. Inlet: Female pipe threads.
7. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads in accordance with NFPA 1963 and matching local fire-department threads.
8. Pattern: Angle.
9. Finish: Polished chrome plated.

## 2.9 ALARM DEVICES

A. Match alarm-device material and connection types to piping and equipment materials and connection types.

B. Water-Motor-Operated Alarm:

1. Standard: UL 753.
2. Type: Mechanically operated, with pelton wheel.
3. Alarm Gong: Cast aluminum with red-enamel factory finish.
4. Size: 10-inch (250-mm) diameter.
5. Components: Shaft length, bearings, and sleeve to suit wall construction.
6. Inlet: NPS 3/4 (DN 20).
7. Outlet: NPS 1 (DN 25) drain connection.

C. Electrically Operated Alarm Bell:

1. Standard: UL 464.
2. Type: Vibrating, metal alarm bell.
3. Size: 6-inch (150-mm) minimum diameter.
4. Finish: Red-enamel factory finish, suitable for outdoor use.

D. Water-Flow Indicators:

1. Standard: UL 346.
2. Water-Flow Detector: Electrically supervised.
3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
4. Type: Paddle operated.
5. Pressure Rating: 250 psig (1725 kPa).
6. Design Installation: Horizontal or vertical.

E. Pressure Switches:

1. Standard: UL 346.
2. Type: Electrically supervised water-flow switch with retard feature.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design Operation: Rising pressure signals water flow.

F. Valve Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled valve is in other than fully open position.

G. Indicator-Post Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled indicator-post valve is in other than fully open position.

## 2.10 PRESSURE GAUGES

- A. Standard: UL 393.
- B. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.
- C. Pressure Gauge Range: 0 to 250-psig (0 to 1725-kPa) minimum.
- D. Water System Piping Gauge: Include "WATER" or "AIR/WATER" label on dial face.
- E. Air System Piping Gauge: Include "AIR" or "AIR/WATER" label on dial face.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 14 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

- B. Report test results promptly and in writing.

### 3.2 EXAMINATION

- A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.
- B. Examine walls and partitions for suitable thickness, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.3 SERVICE-ENTRANCE PIPING

- A. Connect fire-suppression standpipe piping to water-service piping at service entrance into building. Comply with requirements for exterior piping in Section 331415 "Site Water Distribution Piping."
- B. Install shutoff valve, backflow preventer, pressure gauge, drain, and other accessories at connection to fire-suppression water-service piping.

### 3.4 WATER-SUPPLY CONNECTIONS

- A. Connect fire-suppression standpipe piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 221116 "Domestic Water Piping."

### 3.5 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
  - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements in NFPA 14 for installation of fire-suppression standpipe piping.
- C. Install seismic restraints on piping. Comply with requirements in NFPA 13 for seismic-restraint device materials and installation.
- D. Install listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install drain valves on standpipes. Extend drain piping to outside of building.
- F. Install automatic (ball drip) drain valves to drain piping between fire-department connections and check valves. Drain to floor drain or outside building.
- G. Install alarm devices in piping systems.



- H. Install hangers and supports for standpipe system piping in accordance with NFPA 14. Comply with requirements in NFPA 13 for hanger materials.
- I. Install pressure gauges on riser or feed main and at top of each standpipe. Include pressure gauges with connection of not less than NPS 1/4 (DN 8) and with soft-metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they are not subject to freezing.
- J. Fill wet-type standpipe system piping with water.
- K. Install electric heating cables and pipe insulation on wet-type fire-suppression standpipe piping in areas subject to freezing. Comply with requirements for heating cables in Section 210533 "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Section 210700 "Fire-Suppression Systems Insulation."
- L. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- M. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- N. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

### 3.6 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- D. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts in accordance with ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

- H. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings in accordance with AWWA C606 for steel-pipe joints.
- I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings in accordance with AWWA C606 for steel-pipe grooved joints.
- J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
  - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- K. Brazed Joints: Join copper tube and fittings according to Copper Development Association's "Copper Tube Handbook," "Brazed Joints" chapter.
- L. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings in accordance with AWWA C606 for steel-pipe grooved joints.
- M. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

### 3.7 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties in accordance with NFPA 14, authorities having jurisdiction and manufacturer's instructions.
- B. Install listed fire-protection supervised-open shutoff valves, located to control sources of water supply, except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
  - 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
  - 2. Alarm Valves: Install bypass check valve and retarding chamber drain-line connection.

### 3.8 HOSE-CONNECTION INSTALLATION

Indicate hose-connection locations, sizes, and special devices on Drawings.

- A. Install hose connections adjacent to standpipes.
- B. Install freestanding hose connections for access and minimum passage restriction.
- C. Install NPS 2-1/2 (DN 65) hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 (DN 65 by DN 40) reducer adapter and flow-restricting device.

- D. Install wall-mounted-type hose connections in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Comply with requirements for cabinets in Section 104413 "Fire Protection Cabinets."

### 3.9 HOSE-STATION INSTALLATION

- A. Install freestanding hose stations for access and minimum passage restriction.
- B. Install NPS 2-1/2 (DN 65) hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 (DN 65 by DN 40) reducer adapter and flow-restricting device unless otherwise indicated.
- C. Install freestanding hose stations with support or bracket attached to standpipe.
- D. Install wall-mounted, rack hose stations in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Comply with requirements for cabinets in Section 104413 "Fire Protection Cabinets."
- E. Install hose-reel hose stations on wall with bracket.

### 3.10 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping in accordance with NFPA 14 requirements.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 3. Flush, test, and inspect standpipe systems in accordance with NFPA 14, "System Acceptance" chapter.
  - 4. Energize circuits to electrical equipment and devices.
  - 5. Start and run air compressors.
  - 6. Coordinate with fire-alarm tests. Operate as required.
  - 7. Coordinate with fire-pump tests. Operate as required.
  - 8. Verify that equipment hose threads are same as local fire-department equipment.
- C. Fire-suppression standpipe system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.12 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

### 3.13 PIPING SCHEDULE

- A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends, cast-iron threaded fittings, and threaded joints, or grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.
- B. Standard-pressure, wet-type fire-suppression standpipe piping, NPS 4 (DN 100) and smaller, shall be one of the following:
  - 1. Schedule 40 or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
  - 2. Schedule 40, Schedule 30, or thinwall, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
  - 3. Schedule 40 or Schedule 30, black-steel pipe with cut-or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  - 4. Schedule 40 or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  - 5. Schedule 40 or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
  - 6. Thinwall Schedule 10 or lightwall, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  - 7. Thinwall Schedule 10 or lightwall, black-steel pipe with plain ends; welding fittings; and welded joints.
  - 8. Type L (Type B), hard copper tube with plain ends; cast-or wrought-copper solder-joint fittings; and brazed joints.
  - 9. Type L (Type B), hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

END OF SECTION 21 12 00

## SECTION 21 12 13

### FIRE-SUPPRESSION HOSES AND NOZZLES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

###### A. Section Includes:

1. NPS 1-1/2 (DN 40) rack-type hose stations.
2. NPS 1-1/2 by NPS 2-1/2 (DN 40 by DN 65) rack-type hose stations.
3. NPS 1-1/2 (DN 40) reel-type hose stations.
4. Monitors.

###### B. Related Requirements:

1. Section 104413 "Fire Protection Cabinets" for hose cabinets.
2. Section 211200 "Fire-Suppression Standpipes" for fire hose valves.

##### 1.4 ACTION SUBMITTALS

###### A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

###### B. Shop Drawings:

1. Include plans, elevations, sections, and mounting and attachment details.

##### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each product type to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 NPS 1-1/2 (DN 40) RACK-TYPE HOSE STATIONS

#### A. Hose Rack:

1. Standard: UL 47.
2. Material: Brass or bronze with polished chrome-plated finish.
3. Type: Hose-rack assembly. Include hose valve, hose rack, water-retention device, hose pins, and hose.
4. Operation: Semiautomatic.
5. Sized to hold fire hose.

#### B. Hose Valve:

1. Standard: UL 668, NPS 1-1/2 (DN 40), for connecting fire hose.
2. Type: Adjustable.
3. Pressure-Control Device: Pressure reducing.
4. Design Outlet Pressure Setting: Not applicable.
5. Hose Valve and Trim Finish: Polished chrome-plated.
6. Pressure Rating: 300 psig (2070 kPa) minimum.
7. Pattern: Angle.
8. Material: Brass or bronze.
9. Pressure-Control Device: UL 1468 integral or for field installation if indicated.
10. Size: NPS 1-1/2 (DN 40).
11. Inlet: Female pipe threads.
12. Outlet: Male hose threads according to NFPA 1963 and matching local fire-department threads.

#### C. Hose:

1. Standards: NFPA 1961 and UL 219 lined fire hose with swivel inlet, coupling, gaskets, and nozzle.
2. Size: NPS 1-1/2 (DN 40).
3. Length: 50 feet (15 m).
4. Jacket: Combination of natural and synthetic threads.
5. Lining: Rubber, plastic, or combination of rubber and plastic compounds.
6. Cover: Rubber, plastic, or combination of rubber and plastic compounds.
7. Nozzle: UL 401.
  - a. Material: Brass.
  - b. Type: Plain, for nonadjustable water stream.

### 2.2 NPS 1-1/2 BY NPS 2-1/2 (DN 40 BY DN 65) RACK-TYPE HOSE STATIONS

#### A. Hose Rack:

1. Standard: UL 47.
2. Material: Brass or bronze with polished chrome-plated finish.
3. Type: Hose-rack assembly. Include hose valve, reducer adapter, hose rack, water-retention device, hose pins, and hose.
4. Operation: Semiautomatic.
5. Sized to hold fire hose.

B. Hose Valve:

1. Standard: UL 668, NPS 2-1/2 (DN 65), for connecting fire hose.
2. Type: Adjustable.
3. Pressure-Control Device: Pressure reducing.
4. Design Outlet Pressure Setting: Not applicable.
5. Hose Valve and Trim Finish: Polished chrome-plated.
6. Pressure Rating: 300 psig (2070 kPa) minimum.
7. Pattern: Angle.
8. Material: Brass or bronze.
9. Pressure-Control Device: UL 1468, integral or for field installation if indicated.
10. Size: NPS 2-1/2 (DN 65).
11. Inlet: Female pipe threads.
12. Outlet: Male hose threads according to NFPA 1963 and matching local fire-department threads.
13. Reducer Adapter: NPS 2-1/2 by NPS 1-1/2 (DN 65 by DN 40).

C. Hose:

1. Standards: NFPA 1961 and UL 219, lined fire hose with swivel inlet, coupling, gaskets, and nozzle.
2. Size: NPS 1-1/2 (DN 40).
3. Length: 50 feet (15 m).
4. Jacket: Combination of natural and synthetic threads.
5. Lining: Rubber, plastic, or combination of rubber and plastic compounds.
6. Cover: Rubber, plastic, or combination of rubber and plastic compounds.
7. Nozzle: UL 401 spray nozzle unless plain nozzle is indicated.
  - a. Material: Brass.
  - b. Type: Plain, for nonadjustable water stream.

## 2.3 NPS 1-1/2 (DN 40) REEL-TYPE HOSE STATIONS

A. Hose Reel:

1. Standard: UL 47.
2. Hose Reel and Bracket Material: Steel.
3. Type: Hose-reel assembly. Include hose valve, wall bracket, hose reel, water-retention device, hose pins, and hose.
4. Operation: Semiautomatic.
5. Sized to hold fire hose.
6. Finish: Red enamel.

B. Hose Valve:

1. Standard: UL 668, NPS 1-1/2 (DN 40), for connecting fire hose.
2. Type: Adjustable.
3. Pressure-Control Device: Pressure reducing.
4. Design Outlet Pressure Setting: Not applicable.
5. Hose Valve and Trim Finish: Polished chrome-plated.
6. Pressure Rating: 300 psig (2070 kPa) minimum.
7. Pattern: Angle.
8. Material: Brass or bronze.
9. Pressure-Control Device: UL 1468, integral or for field installation if indicated.

10. Size: NPS 1-1/2 (DN 40).
11. Inlet: Female pipe threads.
12. Outlet: Male hose threads according to NFPA 1963 and matching local fire-department threads.

C. Hose:

1. Standards: NFPA 1961 and UL 219 lined fire hose with swivel inlet, coupling, gaskets, and nozzle.
2. Size: NPS 1-1/2 (DN 40).
3. Length: 50 feet (15 m).
4. Jacket: Combination of natural and synthetic threads.
5. Lining: Rubber, plastic, or combination of rubber and plastic compounds.
6. Cover: Rubber, plastic, or combination of rubber and plastic compounds.
7. Nozzle: UL 401.
  - a. Material: Brass.
  - b. Type: Spray, adjustable from shutoff to fog spray or straight stream.

## 2.4 MONITORS

- A. Type: Stationary.
- B. Nozzle: UL 401, NPS 2-1/2 (DN 65), brass, adjustable from fog spray to straight stream to shutoff.
- C. Horizontal Rotation: 360 degrees with locking device.
- D. Vertical Rotation: 80-degree elevation and 60-degree depression with locking device.
- E. Waterway: Double brass or stainless-steel tube.
- F. Waterway Size: NPS 2-1/2 (DN 65).
- G. Water Stream Flow: 500 gpm (31.5 L/s)
- H. Operation: Lever.
- I. Base Inlet Size: NPS 2-1/2 (DN 65).
- J. Finish: Red-painted body with brass trim.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fire hoses, reels, racks, and monitors.
- B. Examine roughing-in for standpipe systems to verify actual locations of piping connections before installation.



- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 HOSE-STATION INSTALLATION

- A. Install freestanding hose stations for access and minimum passage restriction.
- B. Install NPS 1-1/2 (DN 40) hose-station valves with flow-restricting device unless otherwise indicated.
- C. Install NPS 2-1/2 (DN 65) hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 (DN 65 by DN 40) reducer adapter and flow-restricting device unless otherwise indicated.
- D. Install freestanding hose stations with support or bracket attached to standpipe.
- E. Install wall-mounted, rack hose stations in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Comply with requirements for cabinets in Section 104413 "Fire Protection Cabinets."
- F. Install hose-reel hose stations on wall with bracket.

### 3.3 MONITOR INSTALLATION

- A. Install monitors on standpipe piping.

END OF SECTION 21 12 13

## SECTION 21 13 13

### WET-PIPE SPRINKLER SYSTEMS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

###### A. Section Includes:

1. Steel pipe and fittings.
2. Copper tube and fittings.
3. CPVC pipe and fittings.
4. Cover system for sprinkler piping.
5. Specialty valves.
6. Air vent.
7. Sprinkler piping specialties.
8. Sprinklers.
9. Alarm devices.
10. Manual control stations.
11. Control panels.
12. Pressure gauges.

###### B. Related Requirements:

1. Section 211119 "Fire Department Connections" for exposed-, flush-, and yard-type fire department connections.
2. Section 230523 "General-Duty Valves for Water-Based Fire-Suppression Piping" for ball, butterfly, check, gate, post-indicator, and trim and drain valves.
3. Section 331415 "Site Water Distribution Piping" for fire water-service backflow prevention devices.

##### 1.3 DEFINITIONS

- A. High-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure higher than standard 175 psig (1200 kPa), but not higher than 250 psig (1725 kPa).
- B. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig (1200-kPa) maximum.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Sustainable Design Submittals:
- C. Shop Drawings: For wet-pipe sprinkler systems.
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Include diagrams for power, signal, and control wiring.
- D. Delegated Design Submittal: For wet-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Sprinkler systems, or BIM model, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved.
- B. Qualification Data: For qualified Installer and professional engineer.
- C. Design Data:
  - 1. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- D. Welding certificates.
- E. Field Test Reports:
  - 1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
  - 2. Fire-hydrant flow test report.
- F. Field quality-control reports.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

## 1.8 QUALITY ASSURANCE

### A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
  - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

### B. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with NFPA 13.
- C. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.
- D. High-Pressure Piping System Component: Listed for 250-psig (1725-kPa) minimum working pressure.
- E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design wet-pipe sprinkler systems.
  1. Sprinkler system design shall be approved by authorities having jurisdiction.
    - a. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
    - b. Sprinkler Occupancy Hazard Classifications:
      - 1) Building Service Areas: Ordinary Hazard, Group 1.
      - 2) Electrical Equipment Rooms: Ordinary Hazard, Group 1.
      - 3) Elevator Machine Room and Hoistway: Ordinary Hazard, Group 1.
      - 4) General Storage Areas: Ordinary Hazard, Group 1.
      - 5) Laundries: Ordinary Hazard, Group 1.
      - 6) Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
      - 7) Office and Public Areas: Light Hazard.
      - 8) Residential Living Areas: Light Hazard.
      - 9) Restaurant Service Areas: Ordinary Hazard, Group 1.

2. Minimum Density for Automatic-Sprinkler Piping Design:
    - a. Residential (Dwelling) Occupancy: 0.05 gpm over 400-sq. ft. (2.04 mm/min. over 37.2-sq. m) area.
    - b. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. (4.1 mm/min. over 139-sq. m) area.
    - c. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. (6.1 mm/min. over 139-sq. m) area.
    - d. Special Occupancy Hazard: As determined by authorities having jurisdiction.
  3. Maximum Protection Area per Sprinkler:
    - a. Residential Areas: 400 sq. ft. (37 sq. m).
    - b. Office Spaces: 120 sq. ft. (11.1 sq. m).
    - c. Storage Areas: [130 sq. ft. (12.1 sq. m).
    - d. Mechanical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
    - e. Electrical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
    - f. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.
- F. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7. See Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."

## 2.2 STEEL PIPE AND FITTINGS

- A. Standard-Weight, Galvanized- and Black-Steel Pipe: ASTM A53/A53M. Pipe ends may be factory or field formed to match joining method.
- B. Schedule 30, Galvanized-and Black Steel Pipe: ASTM A135/A135M; ASTM A795/A795M; or ASME B36.10M wrought steel, with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.
- C. Thinwall Galvanized and Black Steel Pipe: ASTM A135/A135M or ASTM A795/A795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.
- D. Schedule 10, Black-Steel Pipe: ASTM A135/A135M or ASTM A795/A795M, Schedule 10 in NPS 5 (DN 125) and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10 (DN 150 to DN 250), plain end.
- E. Nonstandard OD, Thinwall Black-Steel Pipe: ASTM A135/A135M or ASTM A795/A795M thinwall with plain ends and wall thickness less than Schedule 10.
- F. Hybrid Black-Steel Pipe: ASTM A135/A135M or ASTM A795/A795M lightwall, with wall thickness less than Schedule 10 and greater than Schedule 5.
- G. Schedule 5 Steel Pipe: ASTM A135/A135M or ASTM A795/A795M lightwall with plain ends.
- H. Galvanized-and Black Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M, standard-weight, seamless steel pipe with threaded ends.
- I. Galvanized and Uncoated Steel Couplings: ASTM A865/A865M, threaded.
- J. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

- K. Malleable- or Ductile-Iron Unions: UL 860.
- L. Cast-Iron Flanges: ASME 16.1, Class 125.
- M. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
  - 1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick.
    - a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
    - b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.
  - 2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.
- N. Steel Welding Fittings: ASTM A234/A234M and ASME B16.9.
  - 1. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- O. Grooved-Joint, Steel-Pipe Appurtenances:
  - 1. Pressure Rating: 175-psig (1200-kPa) minimum.
  - 2. Galvanized Grooved-End Fittings for Steel Piping: ASTM A47/A47M, malleable-iron casting or ASTM A536, ductile-iron casting, with dimensions matching steel pipe.
  - 3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.
- P. Steel Pressure-Seal Fittings: UL 213, FM Global-approved, 175-psig (1200-kPa) pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.

## 2.3 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tube: ASTM B88, Type K (ASTM B88M, Type A), ASTM B88, Type L (ASTM B88M, Type B), and ASTM B88, Type M (ASTM B88M, Type C).
- B. Cast-Copper, Solder-Joint Fittings: ASME B16.18 pressure fittings.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22 pressure fittings.
- D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- E. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
- F. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- G. Copper-Tube, Mechanically Formed Tee Fitting: For forming T-branch on copper water tube.
  - 1. Description: Tee formed in copper tube according to ASTM F2014.
- H. Grooved, Mechanical-Joint, Copper-Tube Appurtenances:
  - 1. Standard: UL 213.

2. Grooved-End Copper Fittings: ASTM B75 (ASTM B75M) copper tube or ASTM B584 bronze castings.
  3. Grooved-End-Tube Couplings: To fit copper tube dimensions; rigid pattern unless otherwise indicated; gasketed fitting EPDM-rubber gasket rated for minimum 180 deg F (80 deg C) for use with ferrous housing and steel bolts and nuts; 300 psig (2060 kPa) minimum CWP pressure rating.
- I. Copper-Tube, Pressure-Seal-Joint Fittings:
1. Fittings: Cast-brass, cast-bronze, or wrought-copper with EPDM O-ring seal in each end.
  2. Minimum 200-psig (1379-kPa) working-pressure rating at 250 deg F (121 deg C).

## 2.4 CPVC PIPE AND FITTINGS

- A. CPVC Pipe: ASTM F442/F442M and UL 1821, SDR 13.5, for 175-psig (1200-kPa) rated pressure at 150 deg F (62 deg C), with plain ends. Include "LISTED" and "CPVC SPRINKLER PIPE" markings.
- B. CPVC Fittings: UL listed or FM Global approved, for 175-psig (1200-kPa) rated pressure at 150 deg F (62 deg C), socket type. Include "LISTED" and "CPVC SPRINKLER FITTING" markings.
1. NPS 3/4 to NPS 1-1/2 (DN 20 to DN 40): ASTM F438 and UL 1821, Schedule 40, socket type.
  2. NPS 2 to NPS 3 (DN 50 to DN 80): ASTM F439 and UL 1821, Schedule 80, socket type.
  3. CPVC-to-Metal Transition Fittings: CPVC, one piece, with dimensions equivalent to pipe; one end with threaded brass insert, and one socket end.
  4. CPVC-to-Metal Transition Unions: CPVC, with dimensions equivalent to pipe; one end with threaded brass insert, and one socket end.
  5. Flanges: CPVC, one or two pieces.
- C. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F493 solvent cement recommended by pipe and fitting manufacturer, and made for joining CPVC sprinkler pipe and fittings. Include cleaner or primer recommended by pipe and fitting manufacturer.
- D. Plastic Pipe-Flange Gasket and Bolts and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

## 2.5 COVER SYSTEM FOR SPRINKLER PIPING

- A. Description: System of support brackets and covers made to protect sprinkler piping.
- B. Brackets: Glass-reinforced nylon.
- C. Covers: Extruded-PVC sections of length, shape, and size required for size and routing of CPVC piping.

## 2.6 SPECIALTY VALVES

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- B. Pressure Rating:
1. Standard-Pressure Piping Specialty Valves: 175-psig (1200-kPa) minimum.

- 2. High-Pressure Piping Specialty Valves: 250-psig (1725-kPa) minimum.
- C. Body Material: Cast or ductile iron.
- D. Size: Same as connected piping.
- E. End Connections: Flanged or grooved.
- F. Alarm Valves:
  - 1. Standard: UL 193.
  - 2. Design: For horizontal or vertical installation.
  - 3. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gauges, retarding chamber, and fill-line attachment with strainer.
  - 4. Drip cup assembly pipe drain with check valve to main drain piping.
  - 5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Deluge Valves:
  - 1. Standard: UL 260.
  - 2. Design: Hydraulically operated, differential-pressure type.
  - 3. Include trim sets for alarm-test bypass, drain, electrical water-flow alarm switch, pressure gauges, drip cup assembly piped without valves and separate from main drain line, and fill-line attachment with strainer.
  - 4. Wet, Pilot-Line Trim Set: Include gauge to read diaphragm-chamber pressure and manual control station for manual operation of deluge valve, and connection for actuation device.
- H. Automatic (Ball Drip) Drain Valves:
  - 1. Standard: UL 1726.
  - 2. Pressure Rating: 175-psig (1200-kPa) minimum.
  - 3. Type: Automatic draining, ball check.
  - 4. Size: NPS 3/4 (DN 20).
  - 5. End Connections: Threaded.

## 2.7 AIR VENT

- A. Manual Air Vent/Valve:
  - 1. Description: Ball valve that requires human intervention to vent air.
  - 2. Body: Forged brass.
  - 3. Ends: Threaded.
  - 4. Minimize Size: 1/2 inch (13 mm).
  - 5. Minimum Water Working Pressure Rating: 300 psig (2070 kPa).
- B. Automatic Air Vent:
  - 1. Description: Automatic air vent that automatically vents trapped air without human intervention.
  - 2. Standard: UL listed or FM Global approved for use in wet-pipe fire sprinkler systems.
  - 3. Vents oxygen continuously from system.
  - 4. Float valve to prevent water discharge.
  - 5. Minimum Water Working Pressure Rating: 175 psig (1207 kPa).
- C. Automatic Air Vent Assembly:



1. Description: Automatic dual air vent assembly that automatically vents trapped air without human intervention, including Y-strainer and ball valve in a pre-piped assembly.
2. Standard: UL listed or FM Global approved for use in wet-pipe fire sprinkler system.
3. Vents oxygen continuously from system.
4. Float valve to prevent water discharge.
5. Minimum Water Working Pressure Rating: 175 psig (1207 kPa).

## 2.8 SPRINKLER PIPING SPECIALTIES

- A. Branch Outlet Fittings:
  1. Standard: UL 213.
  2. Pressure Rating: 175-psig (1200-kPa) minimum.
  3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
  4. Type: Mechanical-tee and -cross fittings.
  5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
  6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
  7. Branch Outlets: Grooved, plain-end pipe, or threaded.
- B. Flow Detection and Test Assemblies:
  1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
  2. Pressure Rating: 175-psig (1200-kPa) minimum.
  3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
  4. Size: Same as connected piping.
  5. Inlet and Outlet: Threaded or grooved.
- C. Branch Line Testers:
  1. Standard: UL 199.
  2. Pressure Rating: 175 psig (1200 kPa).
  3. Body Material: Brass.
  4. Size: Same as connected piping.
  5. Inlet: Threaded.
  6. Drain Outlet: Threaded and capped.
  7. Branch Outlet: Threaded, for sprinkler.
- D. Sprinkler Inspector's Test Fittings:
  1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
  2. Pressure Rating: 175-psig (1200-kPa) minimum.
  3. Body Material: Cast- or ductile-iron housing with sight glass.
  4. Size: Same as connected piping.
  5. Inlet and Outlet: Threaded.
- E. Adjustable Drop Nipples:
  1. Standard: UL 1474.
  2. Pressure Rating: 250-psig (1725-kPa) minimum.
  3. Body Material: Steel pipe with EPDM-rubber O-ring seals.
  4. Size: Same as connected piping.
  5. Length: Adjustable.
  6. Inlet and Outlet: Threaded.
- F. Flexible Sprinkler Hose Fittings:
  1. Standard: UL 1474.
  2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.

3. Pressure Rating: 175-psig (1200-kPa) minimum.
4. Size: Same as connected piping, for sprinkler.

## 2.9 SPRINKLERS

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- B. Pressure Rating for Residential Sprinklers: 175-psig (1200-kPa) maximum.
- C. Pressure Rating for Automatic Sprinklers: 175-psig (1200-kPa) minimum.
- D. Pressure Rating for High-Pressure Automatic Sprinklers: 250-psig (1725-kPa) minimum.
- E. Automatic Sprinklers with Heat-Responsive Element:
  1. Early-Suppression, Fast-Response Applications: UL 1767.
  2. Nonresidential Applications: UL 199.
  3. Residential Applications: UL 1626.
  4. Characteristics: Nominal 1/2-inch (12.7-mm) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- F. Open Sprinklers with Heat-Responsive Element Removed: UL 199.
  1. Nominal Orifice:
    - a. 1/2 inch (12.7 mm), with discharge coefficient K between 5.3 and 5.8.
- G. Sprinkler Finishes: Chrome plated.
- H. Special Coatings: Wax.
- I. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
  1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
  2. Sidewall Mounting: Chrome-plated steel, one piece, flat.
- J. Sprinkler Guards:
  1. Standard: UL 199.
  2. Type: Wire cage with fastening device for attaching to sprinkler.

## 2.10 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Water-Motor-Operated Alarm:
  1. Standard: UL 753.
  2. Type: Mechanically operated, with Pelton wheel.
  3. Alarm Gong: Cast aluminum with red-enamel factory finish.
  4. Size: 8-1/2-inches (216-mm) diameter.
  5. Components: Shaft length, bearings, and sleeve to suit wall construction.

6. Inlet: NPS 3/4 (DN 20).
7. Outlet: NPS 1 (DN 25) drain connection.

C. Electrically Operated Notification Appliances:

1. Electric Bell:
  - a. Standard: UL 464.
  - b. Type: Vibrating, metal alarm bell.
  - c. Size: [6-inch (150-mm) minimum-] [8-inch (200-mm) minimum-] [10-inch (250-mm)] diameter.
  - d. Voltage: [120 V ac, 60 Hz, 1 phase] [24 V dc].
  - e. Finish: Red-enamel or polyester powder-coat factory finish, suitable for outdoor use with approved and listed weatherproof backbox.
2. Strobe/Horn:
  - a. Standard: UL 464.
  - b. Tone: Selectable, steady, Temporal-3 (T-3) in accordance with ISO 8201 and ANSI/ASA S3.41, 2400 Hz, electromechanical, broadband.
  - c. Voltage: 120 V ac, 60 Hz.
  - d. Effective Intensity: 110 cd.
  - e. Finish: Red, suitable for outdoor use with approved and listed weatherproof backbox. White letters on housing identifying device as for "Fire."
  - f. Sign, Integrated: Mount between backbox and strobe/horn with text visible on both sides, above and below strobe/horn. Housing to be shaped to cover surface-mounted weatherproof backbox. Sign is to consist of white lettering on red plastic identifying it as a "Sprinkler Fire Alarm" and instructing viewers to call 911, police, or fire department.

D. Water-Flow Indicators:

1. Standard: UL 346.
2. Water-Flow Detector: Electrically supervised.
3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
4. Type: Paddle operated.
5. Pressure Rating: 250 psig (1725 kPa).
6. Design Installation: Horizontal or vertical.

E. Pressure Switches:

1. Standard: UL 346.
2. Type: Electrically supervised water-flow switch with retard feature.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design Operation: Rising pressure signals water flow.

F. Valve Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled valve is in other than fully open position.
5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.11 MANUAL CONTROL STATIONS

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide" for hydraulic operation, with union, NPS 1/2 (DN 15) pipe nipple, and bronze ball valve.
- B. Include metal enclosure labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.

## 2.12 CONTROL PANELS

- A. Description: Single-area, two-area, or single-area cross-zoned control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves.
  - 1. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide" when used with thermal detectors and Class A detector circuit wiring.
  - 2. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
  - 3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Manual Control Stations, Electric Operation: Metal enclosure, labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.
- C. Panels Components:
  - 1. Power supply.
  - 2. Battery charger.
  - 3. Standby batteries.
  - 4. Field-wiring terminal strip.
  - 5. Electrically supervised solenoid valves and polarized fire-alarm bell.
  - 6. Lamp test facility.
  - 7. Single-pole, double-throw auxiliary alarm contacts.
  - 8. Rectifier.

## 2.13 PRESSURE GAUGES

- A. Standard: UL 393.
- B. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.
- C. Pressure Gauge Range: 0- to 250-psig (0- to 1725-kPa) minimum.
- D. Label: Include "WATER" label on dial face.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

### 3.2 SERVICE-ENTRANCE PIPING

- A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Section 331415 "Site Water Distribution Piping" for exterior piping.
- B. Install shutoff valve, backflow preventer, pressure gauge, drain, and other accessories indicated at connection to water-service piping.

### 3.3 WATER-SUPPLY CONNECTIONS

- A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 221116 "Domestic Water Piping."

### 3.4 INSTALLATION OF PIPING

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
  - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
  - 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
- C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.

- I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- K. Install alarm devices in piping systems.
- L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13. In seismic-rated areas, refer to Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."
- M. Install pressure gauges on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gauges with connection not less than NPS 1/4 (DN 8) and with soft-metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they are not subject to freezing.
- N. Pressurize and check preaction sprinkler system piping and air-pressure maintenance devices and air compressors.
- O. Fill sprinkler system piping with water.
- P. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing. Comply with requirements for heating cables in Section 210533 "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Section 210700 "Fire-Suppression Systems Insulation."
- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

### 3.5 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
- I. Steel-Piping, Pressure-Sealed Joints: Join lightwall and Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
  - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- K. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- L. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- M. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter.
- N. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- O. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and copper pressure-seal fittings with tools recommended by fitting manufacturer.
- P. Extruded-Tee Connections: Form tee in copper tube according to ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- Q. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.
- R. Plastic-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
  - 2. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.

### 3.6 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

- A. Install cover system, brackets, and cover components for sprinkler piping according to manufacturer's "Installation Manual" and NFPA 13 or NFPA 13R for supports.

### 3.7 INSTALLATION OF VALVES AND SPECIALTIES

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
  - 1. Install valves in vertical position for proper direction of flow, in main supply to system.
  - 2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.
  - 3. Install deluge valves in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gauges, priming chamber attachment, and fill-line attachment.
- E. Air Vent:
  - 1. Provide at least one air vent at high point in each wet-pipe sprinkler system in accordance with NFPA 13 requirements. Connect vent into top of fire sprinkler piping.
  - 2. Provide dielectric union for dissimilar metals, ball valve, and strainer upstream of automatic air vent.

### 3.8 INSTALLATION OF SPRINKLERS

- A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.
- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- C. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

### 3.9 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."



### 3.10 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
  - 4. Energize circuits to electrical equipment and devices.
  - 5. Coordinate with fire-alarm tests. Operate as required.
  - 6. Coordinate with fire-pump tests. Operate as required.
  - 7. Verify that equipment hose threads are same as local fire department equipment.
- B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.11 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

### 3.12 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves and pressure-maintenance pumps.

### 3.13 PIPING SCHEDULE

- A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends, cast-iron threaded fittings, and threaded or grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.
- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. Copper-tube, extruded-tee connections may be used for tee branches in copper tubing instead of specified copper fittings. Branch-connection joints must be brazed.
- D. CPVC pipe, Schedule 40 or Schedule 80 CPVC fittings, and solvent-cemented joints may be used for light-hazard and residential occupancies.
- E. Standard-pressure, wet-pipe sprinkler system, NPS 2 (DN 50) and smaller, shall be one of the following:
  - 1. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

2. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
  3. Standard-weight or Schedule 30, black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
  4. Standard-weight or Schedule 30, galvanized-steel pipe with plain ends; galvanized, plain-end-pipe fittings; and twist-locked joints.
  5. Standard-weight or Schedule 30, black-steel pipe with cut or roll grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  6. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  7. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
  8. Thinwall] Schedule 10 nonstandard OD, thinwall or hybrid black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  9. Thinwall Schedule 10 or hybrid black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
  10. Thinwall Schedule 10 nonstandard OD, thinwall or hybrid black-steel pipe with plain ends; welding fittings; and welded joints.
  11. Schedule 5 steel pipe; steel pressure-seal fittings; and pressure-sealed joints.
  12. Type L (Type B) Type M (Type C), hard copper tube with plain ends; cast or wrought copper, solder-joint fittings; and brazed joints.
  13. Type L (Type B) Type M (Type C), hard copper tube with plain ends; copper pressure-seal fittings; and pressure-sealed joints.
  14. NPS 2 (DN 50), Type L (Type B) or Type M (Type C), hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.
- F. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:
1. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
  2. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
  3. Standard-weight or Schedule 30, black-steel pipe with cut or roll grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  4. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  5. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
  6. Thinwall Schedule 10 nonstandard OD, thinwall or hybrid black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  7. Thinwall Schedule 10 nonstandard OD, thinwall or hybrid black-steel pipe with plain ends; welding fittings; and welded joints.
  8. Type L (Type B) Type M (Type C), hard copper tube with plain ends; cast or wrought-copper, solder-joint fittings; and brazed joints.
  9. Type L (Type B) Type M (Type C), hard copper tube with plain ends; copper pressure-seal fittings; and pressure-sealed joints.
  10. Type L (Type B) Type M (Type C), hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

- G. Standard-pressure, wet-pipe sprinkler system, NPS 5 (DN 125) and larger, shall be one of the following:
1. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
  2. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
  3. Standard-weight or Schedule 30, black-steel pipe with cut or roll grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  4. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  5. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
  6. Thinwall Schedule 10 or hybrid black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  7. Thinwall Schedule 10 or hybrid black-steel pipe with plain ends; welding fittings; and welded joints.
  8. Type L (Type B) Type M (Type C), hard copper tube with plain ends; cast or wrought-copper, solder-joint fittings; and brazed joints.
  9. Type L (Type B) Type M (Type C), hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

### 3.14 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
1. Rooms without Ceilings: Upright sprinklers.
  2. Rooms with Suspended Ceilings: Pendent, recessed, flush, and concealed sprinklers as indicated.
  3. Wall Mounting: Sidewall sprinklers.
  4. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated.
  5. Deluge-Sprinkler Systems: Upright and pendent, open sprinklers.
  6. Special Applications: Extended-coverage, flow-control, and quick-response sprinklers where indicated.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
  2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
  3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
  4. Residential Sprinklers: Dull chrome.
  5. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 21 13 13

## SECTION 21 13 16

### DRY-PIPE SPRINKLER SYSTEMS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

###### A. Section Includes:

1. Steel pipe and fittings.
2. Copper tube and fittings.
3. Specialty valves.
4. Preaction sprinkler system nitrogen generator with purge/vent.
5. Sprinkler piping specialties.
6. Sprinklers.
7. Alarm devices.
8. Manual control stations.
9. Control panels.
10. Pressure gauges.

###### B. Related Requirements:

1. Section 211119 "Fire Department Connections" for exposed-, flush-, and yard-type fire department connections.
2. Section 210523 "Fire Protection Piping" for ball, butterfly, check, gate, post-indicator, and trim and drain valves.

##### 1.3 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Dry-pipe sprinkler system piping designed to operate at working pressure of 175-psig (1200-kPa) maximum.

##### 1.4 ACTION SUBMITTALS

###### A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

###### B. Shop Drawings: For dry-pipe sprinkler systems.

1. Include plans, elevations, sections, and attachment details.

2. Include diagrams for power, signal, and control wiring.
- C. Delegated Design Submittal: For dry-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Domestic water piping.
  2. Compressed air piping.
  3. HVAC hydronic piping.
  4. Items penetrating finished ceiling including the following:
    - a. Lighting fixtures.
    - b. Air outlets and inlets.
- B. Qualification Data: For qualified Installer and professional engineer.
- C. Design Data:
1. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- D. Fire-hydrant flow test report.
- E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- F. Field quality-control reports.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For dry-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

## 1.8 QUALITY ASSURANCE

### A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
  - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

## PART 2 - PRODUCTS

### 2.1 SYSTEM DESCRIPTIONS

- A. Double-Interlock Preaction Sprinkler System: Automatic sprinklers are attached to piping containing low-pressure air or nitrogen. Actuation of a fire-detection system, located in same area as sprinklers, will activate the normally closed solenoid but will not open the preaction valve. Activation of a sprinkler head will not permit water to flow into sprinkler piping. Activation of both the normally closed solenoid valve and automatic sprinkler is required to cause the preaction valve to open, permitting water to flow into sprinkler piping, and water will then discharge from opened sprinkler.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with NFPA 13.
- C. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.
- D. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design dry-pipe sprinkler systems.
- E. Sprinkler system design shall be approved by authorities having jurisdiction.
  1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
  2. Sprinkler Occupancy Hazard Classifications:
    - a. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
  3. Minimum Density for Automatic-Sprinkler Piping Design:
    - a. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. (6.1 mm/min. over 139-sq. m) area.
    - b. Special Occupancy Hazard: As determined by authorities having jurisdiction.
  4. Maximum Protection Area per Sprinkler:
    - a. Electrical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
    - b. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

- 5. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:
  - a. Ordinary-Hazard Occupancies: 250 gpm (15.75 L/s) for 60 to 90 minutes.
- F. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7. See Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."

## 2.3 STEEL PIPE AND FITTINGS

- A. Standard-Weight, Galvanized-Steel Pipe: ASTM A53/A53M. Pipe ends may be factory or field formed to match joining method.
- B. Schedule 30, Galvanized-Steel Pipe: ASTM A135/A135M; ASTM A795/A795M; or ASME B36.10M wrought steel, with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.
- C. Thinwall Galvanized-Steel Pipe: ASTM A135/A135M or ASTM A795/A795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.
- D. Galvanized-Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M, standard-weight, seamless steel pipe with threaded ends.
- E. Galvanized-Steel Couplings: ASTM A865/A865M, threaded.
- F. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- G. Malleable- or Ductile-Iron Unions: UL 860.
- H. Cast-Iron Flanges: ASME B16.1, Class 125.
- I. Plain-End-Pipe Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn or screwed retainer pin to secure pipe in fitting.
- J. Grooved-Joint, Steel-Pipe Appurtenances:
  - 1. Pressure Rating: 175-psig (1200-kPa) minimum.
  - 2. Galvanized, Grooved-End Fittings for Steel Piping: ASTM A47/A47M, malleable-iron casting or ASTM A536, ductile-iron casting, with dimensions matching steel pipe.
  - 3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

## 2.4 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tube: ASTM B88, Type L (ASTM B88M, Type B) and ASTM B88, Type M (ASTM B88M, Type C).
- B. Cast-Copper, Solder-Joint Fittings: ASME B16.18 pressure fittings.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22 pressure fittings.
- D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free.
- E. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
- F. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- G. Copper-Tube, Mechanically Formed Tee Fitting: For forming T-branch on copper water tube.
1. Description: Tee formed in copper tube according to ASTM F2014.
- H. Grooved, Mechanical-Joint, Copper-Tube Appurtenances:
1. Standard: UL 213.
  2. Grooved-End Copper Fittings: ASTM B75 (ASTM B75M) copper tube or ASTM B584 bronze castings.
  3. Grooved-End-Tube Couplings: To fit copper tube dimensions; rigid pattern unless otherwise indicated; gasketed fitting EPDM-rubber gasket rated for minimum 180 deg F (80 deg C) for use with ferrous housing and steel bolts and nuts; 300 psig (2060 kPa) minimum CWP pressure rating.
- I. Copper-Tube, Pressure-Seal-Joint Fittings:
1. Fittings: Cast-brass, cast-bronze, or wrought-copper with EPDM O-ring seal in each end.
  2. Minimum 200-psig (1379-kPa) working-pressure rating at 250 deg F (121 deg C).

## 2.5 SPECIALTY VALVES

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- B. Pressure Rating:
1. Standard-Pressure Piping Specialty Valves: 175-psig (1200-kPa) minimum.
- C. Body Material: Cast or ductile iron.
- D. Size: Same as connected piping.
- E. End Connections: Flanged or grooved.
- F. Dry-Pipe Valves:
1. Standard: UL 260.
  2. Design: Differential-pressure type.
  3. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gauges, priming chamber attachment, and fill-line attachment.
  4. Air-Pressure Maintenance Device:
    - a. Standard: UL 260.
    - b. Type: Automatic device to maintain minimum air pressure in piping.
    - c. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig (95- to 410-kPa) adjustable range, and 175-psig (1200-kPa) outlet pressure.
- G. Preaction Valves:



1. Standard: UL 260.
2. Design: Hydraulically operated, differential-pressure type.
3. Include trim sets for alarm-test bypass, drain, electrical water-flow alarm switch, pressure gauges, drip cup assembly piped without valves and separate from main drain line, and fill-line attachment with strainer.
4. Dry, Pilot-Line Trim Set: Include dry, pilot-line actuator; air- and water-pressure gauges; low-air-pressure warning switch; air relief valve; and actuation device. Dry, pilot-line actuator includes cast-iron, operated, diaphragm-type valve with resilient facing plate, resilient diaphragm, and replaceable bronze seat. Valve includes threaded water and air inlets and water outlet. Loss of air pressure on dry, pilot-line side allows pilot-line actuator to open and causes deluge valve to open immediately.
5. Air-Pressure Maintenance Device:
  - a. Standard: UL 260.
  - b. Type: Automatic device to maintain minimum air pressure in piping.
  - c. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig (95- to 410-kPa) adjustable range, and 175-psig (1200-kPa) outlet pressure.
6. Air Compressor:
  - a. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
  - b. Motor Horsepower: Fractional.
    - 1) Power: 120-V ac, 60 Hz, single phase.
  - c. Sized for application and capable of achieving system supervisory pressure within 30 minutes in accordance with requirements of NFPA 13. Provide ASME air receiver tank as required to meet requirements on larger systems.
  - d. Include filters, relief valves, coolers, automatic drains, and gauges.

H. Automatic (Ball Drip) Drain Valves:

1. Standard: UL 1726.
2. Pressure Rating: 175-psig (1200-kPa) minimum.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4 (DN 20).
5. End Connections: Threaded.

## 2.6 PREACTION SPRINKLER SYSTEM NITROGEN GENERATOR WITH PURGE/VENT

A. Preaction Sprinkler System Nitrogen Generator Corrosion-Mitigation with Purge/Vent: Nitrogen generator system to serve preaction sprinkler zones for piping corrosion mitigation, including system venting.

1. Description: Nitrogen generator system for preaction sprinkler system providing required supervisory pressure within sprinkler zone. System is to include either an integrated, oil-less air compressor located within the nitrogen generator system package, or a separate vibration-isolation mounted air compressor, also provided by nitrogen generator manufacturer.
2. Standards:
  - a. FM Approvals 1035.
  - b. UL 508A listed.
3. Nitrogen Generator:

- a. Wall-mounted, Skid-mounted, or Stand-alone nitrogen generator to provide minimum nitrogen purity of 98 percent to the designated sprinkler systems.
  - b. Power: 120 V ac.
  - c. Bypass mode and nitrogen generating mode.
  - d. Minimum Capacity: As recommended by manufacturer.
4. Air Compressor:
- a. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
  - b. Motor Horsepower: Fractional.
    - 1) Power: 120 V ac, 60 Hz, single phase.
  - c. Sized for application and capable of achieving system supervisory pressure within 30 minutes in accordance with requirements of NFPA 13. Provide ASME air receiver tank as required to meet requirements on larger systems.
  - d. Include filters, relief valves, coolers, automatic drains, and gauges.
  - e. Minimum Capacity: Match capacity of nitrogen generator.
5. Automatic Purge Vent/Valve:
- a. Vents oxygen during system nitrogen fill.
  - b. Automatically closes when 98 percent minimum nitrogen has been reached.
  - c. Sized to allow correct purge rate per manufacturer's written instructions and with 14 days.
  - d. Provide one venting device for each dry/preaction sprinkler system zone.
  - e. Include a connection port for a portable nitrogen purity sensor or a nitrogen purity manifold.
6. Supervisory Gas Monitoring - Nitrogen Purity Sensing Device:
- a. Portable Handheld Nitrogen Purity Sensing Device: Portable sensing device to connect to the outlet of automatic purge/vent valve during periodic inspections to obtain a nitrogen purity reading within each zone.
  - b. Permanently Mounted Nitrogen Purity Monitoring Device or Manifold: Permanent monitoring device to continuously monitor system's nitrogen purity.
7. BAS Alarm Integration:
- a. Provide nitrogen generation system with integrated leak detection and bypass alarms. Program alarms into controller and connect to BAS.
    - 1) Leak detection system is to alarm if leaks develop within fire-suppression system piping.
    - 2) Air bypass alarm is to alarm if nitrogen generation system is bypassed by air compressor.

## 2.7 SPRINKLER PIPING SPECIALTIES

- A. General Requirements for Dry-Pipe System Fittings: UL listed for dry-pipe service.
- B. Branch Outlet Fittings:
  - 1. Standard: UL 213.

2. Pressure Rating: 175-psig (1200-kPa) minimum.
  3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
  4. Type: Mechanical-tee and -cross fittings.
  5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
  6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
  7. Branch Outlets: Grooved, plain-end pipe, or threaded.
- C. Flow Detection and Test Assemblies:
1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
  2. Pressure Rating: 175-psig (1200-kPa) minimum.
  3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
  4. Size: Same as connected piping.
  5. Inlet and Outlet: Threaded.
- D. Branch Line Testers:
1. Standard: UL 199.
  2. Pressure Rating: 175-psig (1200-kPa) minimum.
  3. Body Material: Brass.
  4. Size: Same as connected piping.
  5. Inlet: Threaded.
  6. Drain Outlet: Threaded and capped.
  7. Branch Outlet: Threaded, for sprinkler.
- E. Sprinkler Inspector's Test Fittings:
1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
  2. Pressure Rating: 175-psig (1200-kPa) minimum.
  3. Body Material: Cast- or ductile-iron housing with sight glass.
  4. Size: Same as connected piping.
  5. Inlet and Outlet: Threaded.
- F. Adjustable Drop Nipples:
1. Standard: UL 1474.
  2. Pressure Rating: 250-psig (1725-kPa) minimum.
  3. Body Material: Steel pipe with EPDM O-ring seals.
  4. Size: Same as connected piping.
  5. Length: Adjustable.
  6. Inlet and Outlet: Threaded.
- G. Flexible Sprinkler Hose Fittings:
1. Standard: UL 1474.
  2. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
  3. Pressure Rating: 175-psig (1200-kPa) minimum.
  4. Size: Same as connected piping, for sprinkler.

## 2.8 SPRINKLERS

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- B. Pressure Rating for Residential Sprinklers: 175-psig (1200-kPa) maximum.
- C. Pressure Rating for Automatic Sprinklers: 175-psig (1200-kPa) minimum.

- D. Pressure Rating for High-Pressure Automatic Sprinklers: 250-psig (1725-kPa) minimum.
- E. Automatic Sprinklers with Heat-Responsive Element:
  - 1. Nonresidential Applications: UL 199.
  - 2. Residential Applications: UL 1626.
  - 3. Characteristics: Nominal 1/2-inch (12.7-mm) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- F. Sprinkler Finishes: Chrome plated.
- G. Special Coatings: Wax.
- H. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
  - 1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
  - 2. Sidewall Mounting: Chrome-plated steel, one piece, flat.
- I. Sprinkler Guards:
  - 1. Standard: UL 199.
  - 2. Type: Wire cage with fastening device for attaching to sprinkler.

## 2.9 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Water-Motor-Operated Alarm:
  - 1. Standard: UL 753.
  - 2. Type: Mechanically operated, with Pelton wheel.
  - 3. Alarm Gong: Cast aluminum with red-enamel factory finish.
  - 4. Size: 10-inch (250-mm) diameter.
  - 5. Components: Shaft length, bearings, and sleeve to suit wall construction.
  - 6. Inlet: NPS 3/4 (DN 20).
  - 7. Outlet: NPS 1 (DN 25) drain connection.
- C. Electrically Operated Alarm Notification Appliances:
  - 1. Electric Bell:
    - a. Standard: UL 464.
    - b. Type: Vibrating, metal alarm bell.
    - c. Size: 6-inch (150-mm) minimum diameter.
    - d. Voltage: 120 V ac, 60 Hz, 1 phase.
    - e. Finish: Red-enamel or polyester powder-coat factory finish, suitable for outdoor use with approved and listed weatherproof backbox.
  - 2. Strobe/Horn:
    - a. Standard: UL 464.
    - b. Tone: Selectable, steady, Temporal-3 (T-3) in accordance with ISO 8201 and ANSI/ASA S3.41, 2400 Hz, electromechanical, broadband.
    - c. Voltage: 120 V ac, 60 Hz.

- d. Effective Intensity: 110 cd.
- e. Finish: Red, suitable for outdoor use with approved and listed weatherproof backbox. White letters on housing identifying device as for "Fire."
- f. Sign, Integrated: Mount between backbox and strobe/horn with text visible on both sides, above and below strobe/horn. Housing to be shaped to cover surface-mounted weatherproof backbox. Sign is to consist of white lettering on red plastic identifying it as a "Sprinkler Fire Alarm" and instructing viewers to call 911, police, or fire department.

D. Pressure Switches - Water-Flow Alarm Detection:

- 1. Standard: UL 346.
- 2. Type: Electrically supervised, pressure-activated water-flow switch.
- 3. Components: Two single-pole, double-throw switches.
- 4. Design Operation: Rising pressure to 6 psi (40 kPa), plus or minus 2 psi (13.8 kPa) signals water flow.
- 5. Adjustability: Each switch is to be independently adjustable.
- 6. Wire Separation: Pressure switch to provide separation of wiring to each switch connection to allow for low and high volume connections to comply with NFPA 70 Article 760 requirements.

E. Pressure Switches - Low/High Air Pressure Supervisory:

- 1. Standard: UL 346.
- 2. Type: Electrically supervised pressure supervisory switch.
- 3. Components: Two single-pole, double-throw switches.
- 4. Design Operation: Detects increase and/or decrease from normal supervisory air pressure.
- 5. Adjustability: Each switch is to be independently adjustable.
- 6. Wire Separation: Pressure switch shall provide for separation of wiring to each switch connection to allow for low and high voltage connections to comply with NFPA 70 Article 760 requirements.

F. Valve Supervisory Switches:

- 1. General Requirements for Valve Supervisory Switches:
  - a. Standard: UL 346.
  - b. Type: Electrically supervised.
  - c. Design: Signals that controlled valve is in other than fully open position.
  - d. Wire Terminal Designations: Indicates normal switch position when switch is properly installed on the valve and valve is fully open.
- 2. Requirements for OS&Y Valve Supervisory Switches:
  - a. Components: One or two single-pole, double-throw switches.
  - b. NEMA Rating: NEMA 4 and NEMA 6P enclosures suitable for mounting in any position indoors or outdoors.
  - c. Visual Switch Indication: Indicates device is properly installed and OS&Y valve is fully open.
  - d. Mounting Hardware: Mounting bracket to grip valve yoke and prevent movement of switch assembly on OS&Y valve.
  - e. Trip Rod Length: Adjustable.
- 3. Requirements for PIV and Butterfly Valve Supervisory Switches:
  - a. Components: Two single-pole, double-throw switches.
  - b. NEMA Rating: NEMA 4 and NEMA 6P enclosures suitable for mounting in any position indoors or outdoors.

- c. Mounting Hardware: Removable nipple.
  - d. Trip Rod Length: Adjustable.
4. Requirements for Ball Valve Supervisory Switch:
- a. Components: One single-pole, double-throw switch.
  - b. NEMA Rating: NEMA 4 enclosure suitable for mounting in any position indoors or outdoors.
  - c. Mounting Hardware: Suitable for mounting directly to pipe, ball valves or backflow preventers sized from up to NPS 2 (DN 50).

## 2.10 CONTROL PANELS

- A. Description: Single-area, two-area, or single-area cross-zoned type control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves.
- 1. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide" when used with thermal detectors and Class A detector circuit wiring.
  - 2. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
  - 3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application
- B. Manual Control Stations, Electric Operation: Metal enclosure, labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.
- C. Panels Components:
- 1. Power supply.
  - 2. Battery charger.
  - 3. Standby batteries.
  - 4. Field-wiring terminal strip.
  - 5. Electrically supervised solenoid valves and polarized fire-alarm bell.
  - 6. Lamp test facility.
  - 7. Single-pole, double-throw auxiliary alarm contacts.
  - 8. Rectifier.

## 2.11 PRESSURE GAUGES

- A. Standard: UL 393.
- B. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.
- C. Pressure Gauge Range: 0- to 250-psig (0- to 1725-kPa) minimum.
- D. Label: Include "WATER" or "AIR/WATER" label on dial face.
- E. Air System Piping Gauge: Include retard feature and "AIR" or "AIR/WATER" label on dial face.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

### 3.2 WATER-SUPPLY CONNECTIONS

- A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 221116 "Domestic Water Piping."

### 3.3 INSTALLATION OF PIPING

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
  - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
  - 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
- C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. Install automatic (ball drip) drain valves to drain piping between fire department connections and check valves. Drain to floor drain or to outside building.
- K. Connect compressed-air supply to dry-pipe sprinkler piping.
- L. Install alarm devices in piping systems.

- M. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements in NFPA 13. In seismic-rated areas, refer to Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."
- N. Install pressure gauges on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gauges with connection not less than NPS 1/4 (DN 8) and with soft-metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they are not subject to freezing.
- O. Drain dry-pipe sprinkler piping.
- P. Pressurize and check dry-pipe sprinkler system piping and air-pressure maintenance devices.
- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

### 3.4 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.



- I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- J. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.
- K. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- L. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and copper pressure-seal fittings with tools recommended by fitting manufacturer.
- M. Extruded-Tee Connections: Form tee in copper tube according to ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- N. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

### 3.5 INSTALLATION OF VALVES AND SPECIALTIES

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
  - 1. Install valves in vertical position for proper direction of flow, in main supply to system.
  - 2. Install dry-pipe and deluge valves with trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gauges, priming chamber attachment, and fill-line attachment.
    - a. Install air compressor and compressed-air-supply piping.

### 3.6 INSTALLATION OF SPRINKLERS

- A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.
- B. Install sprinklers with water supply from heated space. Do not install pendent or sidewall sprinklers in areas subject to freezing.
- C. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

### 3.7 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.8 NITROGEN-GENERATION, CORROSION-MITIGATION SYSTEM

- A. Install in accordance with manufacturer's written installation instructions.
- B. Locate purge vent/valve in accordance with manufacturer's written installation instructions.
- C. Route alarm signals in code-approved electrical conduit from nitrogen generator system control panel to the supervisory circuit of BAS.

### 3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
  - 4. Energize circuits to electrical equipment and devices.
  - 5. Start and run air compressors.
  - 6. Coordinate with fire-alarm tests. Operate as required.
  - 7. Coordinate with fire-pump tests. Operate as required.
  - 8. Verify that equipment hose threads are same as local fire department equipment.
- B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.10 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

### 3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

### 3.12 PIPING SCHEDULE

- A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends, cast-iron threaded fittings, and threaded or grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.
- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. Copper-tube, extruded-tee connections may be used for tee branches in copper tubing instead of specified copper fittings. Branch-connection joints must be brazed.
- D. Standard-pressure, dry-pipe sprinkler system, NPS 2 (DN 50) and smaller, shall be one of the following:
  - 1. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
  - 2. Standard-weight Schedule 30 or thinwall, galvanized-steel pipe with plain ends; plain-end-pipe fittings; and twist-locked joints.
  - 3. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  - 4. Type L (Type B) Type M (Type C), hard copper tube with plain ends; cast or wrought copper, solder-joint fittings; and brazed joints.
  - 5. Type L (Type B) Type M (Type C), hard copper tube with plain ends; copper pressure-seal fittings; and pressure-sealed joints.
  - 6. NPS 2 (DN 50), Type L (Type B) Type M (Type C), hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.
- E. Standard-pressure, dry-pipe sprinkler system, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:
  - 1. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
  - 2. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
  - 3. Type L (Type B) Type M (Type C), hard copper tube with plain ends; cast or wrought copper, solder-joint fittings; and brazed joints.
  - 4. Type L (Type B) Type M (Type C), hard copper tube with plain ends; copper pressure-seal fittings; and pressure-sealed joints.
  - 5. Type L (Type B) Type M (Type C), hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

### 3.13 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
  - 1. Rooms without Ceilings: Upright sprinklers.
  - 2. Rooms with Suspended Ceilings: Dry pendent, recessed, flush, and concealed sprinklers as indicated.
  - 3. Wall Mounting: Dry sidewall sprinklers.
  - 4. Spaces Subject to Freezing: Upright, dry pendent sprinklers; and dry sidewall sprinklers as indicated.

5. Special Applications: Extended-coverage and quick-response sprinklers where indicated.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
  2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
  3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
  4. Upright, Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 21 13 16

SECTION 21 22 00

CLEAN-AGENT FIRE-EXTINGUISHING SYSTEMS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

- A. Section Includes:
  - 1. Clean-agent fire-extinguishing systems.
  - 2. Pipe and fittings.
  - 3. Valves.
  - 4. Extinguishing-agent containers.
  - 5. Fire-extinguishing clean agent.
  - 6. Discharge nozzles.
  - 7. Manifold and orifice unions.
  - 8. Fire control panels.
  - 9. Detection devices.
  - 10. Manual stations.
  - 11. Switches.
  - 12. Alarm devices.

1.4 DEFINITIONS

- A. EPO: Emergency Power Off.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Sustainable Design Submittals:
- C. Shop Drawings: Prepare in accordance with requirements of NFPA 2001, to include, but not be limited to, the following:
  - 1. Include plans, elevations, sections, and attachment details.

2. Include design calculations.
  3. Include details of equipment assemblies. Indicate dimensions, weights, loads, manufacturer-required clearances, method of field assembly, components, and location and size of each field connection.
  4. Include diagrams for power, signal, and control wiring.
  5. Permit-Approved Documents: Working plans and hydraulic calculations approved by authorities having jurisdiction.
- D. Delegated-Design Submittal: For clean-agent fire-extinguishing systems indicated to comply with performance and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades. Coordinate for enclosure integrity in accordance with NFPA 2001 requirements.
- B. Seismic Qualification Data: Certificates for extinguishing-agent containers and control panels, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Welding certificates.
- D. Field quality-control reports.

## 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For clean-agent fire-extinguishing system to include in emergency, operation, and maintenance manuals.

## 1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.
1. Detection Devices: Not less than 20 percent of amount of each type installed.
  2. Container Valves: Not less than 10 percent of amount of each size and type installed.
  3. Nozzles: Not less than 20 percent of amount of each type installed.
  4. Extinguishing Agent: Not less than 100 percent of amount installed in largest hazard area. Include pressure-rated containers with valves.

## 1.9 QUALITY ASSURANCE

- A. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. FM Global Compliance: Provide components that are FM Approved and that are listed in FM Approvals' "Approval Guide."
- C. UL Compliance: Provide equipment listed in UL's "Fire Protection Equipment Directory."
- D. Seismic Performance: Fire-suppression piping shall withstand the effects of earthquake motions determined in accordance with NFPA 13 and ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  - 2. Component Importance Factor: 1.5.

### 2.2 CLEAN-AGENT SYSTEMS

- A. Source Limitations: Obtain clean-agent systems from single source from single manufacturer.
- B. Description: Clean-agent fire-extinguishing system shall be an engineered system for total flooding of the hazard area including the room cavity above the ceiling, below the ceiling, and below the raised floor. System includes separate zones above and below the ceiling and beneath the raised floor. If smoke is detected below the raised floor, extinguishing agent shall be discharged in the underfloor zone only. If smoke is detected below the ceiling, extinguishing agent shall be discharged in zones above and below the ceiling and below the floor. If smoke is detected above the ceiling, extinguishing agent shall be discharged in the zone above the ceiling only.
- C. Delegated Design: Design clean-agent fire-extinguishing system and obtain approval from authorities having jurisdiction. Design system for Class A Class B or Class C fires as appropriate for areas being protected, and include safety factor. Use clean agent indicated and in concentration suitable for normally occupied areas.
- D. Performance Requirements: Discharge HFC 227ea within 10 seconds and maintain 7.1 percent concentration by volume at 70 deg F (21 deg C) for 10-minute holding time in hazard areas.
  - 1. HFC 227ea concentration in hazard areas greater than 9.0 percent immediately after discharge or less than 5.8 percent throughout holding time will not be accepted without written authorization from Owner and authorities having jurisdiction.
  - 2. System Capabilities: Minimum 620-psig (4278-kPa) calculated working pressure and 360-psig (2484-kPa) initial charging pressure.

- E. Cross-Zoned Detection: Devices located in two separate zones. Sound alarm on activating single-detection device, and discharge extinguishing agent on actuating single-detection device in another zone.
- F. Verified Detection: Devices located in single zone. Sound alarm on activating single-detection device, and discharge extinguishing agent on actuating second-detection device.
- G. System Operating Sequence: System shall be cross-zoned, air-sampling detectors and photoelectric detectors reporting to a fully programmable microprocessor-based control panel programmed to operate as follows:
  - 1. If one photoelectric detector and air-sampling detector reaches the third detection level (Fire 1), agent discharge will be initiated as described for the third detection level (Fire 1) below.
  - 2. Air-Sampling System:
    - a. First Detection Level (Alert): Mild audible and visual indication on annunciator panel. Strobe lights flash slowly in the protected area.
    - b. Second Detection Level (Action): Strong audible and visual indication on annunciator panel. Strobe lights flash rapidly in the protected area.
    - c. Third Detection Level (Fire 1): Strong audible and visual indication on annunciator panel. Energize horn(s), bell(s), and strobe light(s) in the protected area and outside entry doors. Shut down air-conditioning and ventilating systems serving the protected area, and close doors in the protected area. Send signal to fire-alarm system, initiate 30-second time delay for extinguishing-agent discharge, and discharge extinguishing agent. At agent discharge, terminate power to equipment in the protected area, and release preaction valve to allow water flow to sprinkler system.
    - d. Fourth Detection Level (Fire 2): Same as Fire 1.
- H. Manual stations shall immediately discharge extinguishing agent when activated.
- I. Operating abort switches will delay extinguishing-agent discharge while being activated, and switches must be reset to prevent agent discharge. Release hand pressure on the switch to cause agent discharge after the time delay has expired.
- J. EPO: Will terminate power to protected equipment immediately on actuation.
- K. Low-Agent Pressure Switch: Initiate trouble alarm if sensing less than set pressure.
- L. Power Transfer Switch: Transfer from normal to standby power source.

## 2.3 PIPE AND FITTINGS

- A. See "HFC 227ea Agent Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Piping, Valves, and Discharge Nozzles: Comply with types and standards listed in NFPA 2001, Section "Distribution," for charging pressure of system.
- C. Steel Pipe: ASTM A53/A53M, Type S, Grade B or ASTM A106/A106M; Schedule 40, Schedule 80, and Schedule 160, seamless steel pipe.
  - 1. Threaded Fittings:



- a. Malleable-Iron Fittings: ASME B16.3, Class 300.
  - b. Flanges and Flanged Fittings: ASME B16.5, Class 300 unless Class 600 is indicated.
  - c. Fittings Working Pressure: 620 psig (4278 kPa) minimum.
  - d. Flanged Joints: Class 300 minimum.
- 2. Forged-Steel Welding Fittings: ASME B16.11, Class 3000, socket pattern.
  - 3. Steel, Grooved-End Fittings: FM Approved and NRTL listed, ASTM A47/A47M malleable iron or ASTM A536 ductile iron, with dimensions matching steel pipe and ends factory grooved in accordance with AWWA C606.
- D. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
    - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch- (3.2-mm-) maximum thickness unless thickness or specific material is indicated.
- E. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.
- F. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- G. Steel, Keyed Couplings: UL 213, AWWA C606, approved or listed for clean-agent service, and matching steel-pipe dimensions. Include ASTM A536, ductile-iron housing, rubber gasket, and steel bolts and nuts.

## 2.4 VALVES

- A. General Valve Requirements:
  - 1. UL listed or FM Approved for use in fire-protection systems.
  - 2. Compatible with type of clean agent used.
- B. Container Valves: With rupture disc or solenoid and manual-release lever, capable of immediate and total agent discharge and suitable for intended flow capacity.
- C. Valves in Sections of Closed Piping and Manifolds: Fabricate to prevent entrapment of liquid, or install valve and separate pressure relief device.
- D. Valves in Manifolds: Check valve; installed to prevent loss of extinguishing agent when container is removed from manifold.

## 2.5 EXTINGUISHING-AGENT CONTAINERS

- A. Description: Steel tanks complying with ASME Boiler and Pressure Vessel Code: Section VIII, for unfired pressure vessels. Include minimum working-pressure rating that matches system charging pressure, valve, pressure switch, and pressure gage.
  - 1. Finish: Manufacturer's standard color, enamel or epoxy paint.
  - 2. Manifold: Fabricate with valves, pressure switches, selector switch, and connections for main- and reserve-supply banks of multiple storage containers.

3. Storage-Tank Brackets: Factory- or field-fabricated retaining brackets consisting of steel straps and channels; suitable for container support, maintenance, and tank refilling or replacement.

## 2.6 FIRE-EXTINGUISHING CLEAN AGENT

- A. HFC 227ea Clean Agent: Heptafluoropropane.
  1. Source Limitations: Obtain clean agents from single source from single manufacturer.

## 2.7 DISCHARGE NOZZLES

- A. Description: Equipment manufacturer's standard one-piece brass or aluminum alloy of type, size, discharge pattern, and capacity required for application.
- B. Material: Corrosion-resistant metal.
- C. Stamped with orifice size and type.

## 2.8 FIRE CONTROL PANELS

- A. Description: FM Approved or NRTL listed, including equipment and features required for testing, supervising, and operating fire-extinguishing system.
- B. Power Requirements: 120/240 V ac; with electrical contacts for connection to system components and fire-alarm system, and transformer or rectifier as needed to produce power at voltage required for accessories and alarm devices.
- C. Enclosure: NEMA ICS 6, Type 1, enameled-steel cabinet.
  1. Mounting: Recessed flush with surface.
- D. Supervised Circuits: Separate circuits for each independent hazard area.
  1. Detection circuits equal to required number of zones, or addressable devices assigned to required number of zones.
  2. Manual pull-station circuit.
  3. Alarm circuit.
  4. Release circuit.
  5. Abort circuit.
  6. EPO circuit.
- E. Control-Panel Features:
  1. Electrical contacts for shutting down fans, activating dampers, and operating system electrical devices.
  2. Automatic switchover to standby power at loss of primary power.
  3. Storage container, low-pressure indicator.
  4. Service disconnect to interrupt system operation for maintenance with visual status indication on the annunciator panel.
- F. Annunciator Panel: Graphic type showing protected, hazard-area plans, as well as locations of detectors and abort, EPO, and manual stations. Include lamps to indicate device-initiating

alarm, electrical contacts for connection to control panel, and stainless steel or aluminum enclosure.

- G. Standby Power: Sealed lead calcium batteries with capacity to operate system for 24 hours and alarm for minimum of 15 minutes. Include automatic battery charger that has a varying charging rate between trickle and high depending on battery voltage, and that is capable of maintaining batteries fully charged. Include manual voltage control, dc voltmeter, dc ammeter, electrical contacts for connection to control panel, automatic transfer switch, and suitable enclosure.

## 2.9 DETECTION DEVICES

- A. Description: Comply with NFPA 2001, NFPA 72, and UL 268; 24 V dc, nominal.
- B. Ionization Detectors: Dual-chamber type, having sampling and referencing chambers, with smoke-sensing element.
- C. Photoelectric Detectors: LED light source and silicon photodiode receiving element.
- D. Remote Air-Sampling Detector System: Includes air-sampling pipe network, laser-based photoelectric detector, sample transport fan, and control unit.
  - 1. Pipe Network: CPVC tubing connects control unit with calibrated sampling holes.
  - 2. Smoke Detector: Particle-counting type with continuous laser beam. Sensitivity adjustable to a minimum of four preset values.
  - 3. Sample Transport Fan: Centrifugal type, creating a minimum static pressure of 0.05 inch wg (12.5 Pa) at all sampling ports.
  - 4. Control Unit: Multizone unit as indicated on Drawings. Provides same system power supply, supervision, and alarm features as specified for the control panel plus separate trouble indication for airflow and detector problems.
- E. Signals to the Central Fire-Alarm Control Panel: Any type of local system trouble is reported to central fire-alarm control panel as a composite "trouble" signal. Alarms on each system zone are individually reported to central fire-alarm control panel as separately identified zones.

## 2.10 MANUAL STATIONS

- A. Description: Surface FM Approved or NRTL listed, with clear plastic hinged cover, 120-V ac or low-voltage compatible with controls. Include contacts for connection to control panel.
- B. Manual Release: "MANUAL RELEASE" caption, and red finish. Unit can manually discharge extinguishing agent with operating device that remains engaged until unlocked.
- C. Abort Switch: "ABORT" caption, momentary contact, with green finish.
- D. EPO Switch: "EPO" caption, with yellow finish.

## 2.11 SWITCHES

- A. Description: FM Approved or NRTL listed, where available, 120-V ac or low-voltage compatible with controls. Include contacts for connection to control panel.
  - 1. Low-Agent Pressure Switches: Pneumatic operation.

2. Power Transfer Switches: Key-operation selector, for transfer of release circuit signal from main supply to reserve supply.
3. Door Closers: Magnetic retaining and release device or electrical interlock to cause door operator to drive the door closed.

## 2.12 ALARM DEVICES

- A. Description: FM Approved or NRTL listed, low voltage, and surface mounting. Comply with requirements in Section 284621.11 "Addressable Fire-Alarm Systems" or Section 284621.13 "Conventional Fire-Alarm Systems" for alarm and monitoring devices.
- B. Bells: Minimum 6-inch (150-mm) diameter.
- C. Horns: 90 to 94 dBA.
- D. Strobe Lights: Translucent lens, with "FIRE" or similar caption.
- E. Oxygen Deficiency Monitor.
  1. Sampling Method and Range: Diffusion, zero to 25 percent O<sub>2</sub>.
  2. 24 V dc.
  3. Wall mounted with bracket.
  4. Built-in audible alarm 90 dBA.
  5. Backlit LCD.
  6. 10-year no-calibration sensor.
  7. No maintenance required.
  8. Signal Outputs: Standard 4- to 20-mA analog.
  9. Connections for system control data acquisition system and/or programmable logic controller.
  10. Plus or minus 1 percent accuracy of full scale.
  11. Operating temperature of minus 40 to plus 122 deg F (minus 40 to plus 50 deg C).

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with enclosure integrity requirements, installation tolerances, and other conditions affecting performance of the Work in accordance with NFPA 2001.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 HFC 227ea AGENT PIPING APPLICATIONS

- A. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.
- B. NPS 2 (DN 50) and Smaller: Schedule 40, steel pipe; malleable-iron threaded fittings; and threaded joints.

- C. NPS 2-1/2 (DN 65) and Larger: Schedule 40, steel pipe; forged-steel welding fittings; and welded joints or steel, grooved-end fittings; steel, keyed couplings; and grooved joints.

### 3.3 CLEAN-AGENT SYSTEM INSTALLATION

- A. Install clean-agent containers, piping, and other components level and plumb, in accordance with manufacturers' written instructions.
- B. Clean-Agent Container Mounting:
  - 1. Install clean-agent containers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
  - 2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."
- C. Grooved Piping Joints: Groove pipe ends in accordance with AWWA C606 dimensions. Assemble grooved-end steel pipe and steel, grooved-end fittings with steel, keyed couplings and lubricant in accordance with manufacturer's written instructions.
- D. Install pipe and fittings, valves, and discharge nozzles in accordance with requirements listed in NFPA 2001, Section "Distribution."
  - 1. Install valves designed to prevent entrapment of liquid, or install pressure relief devices in valved sections of piping systems.
  - 2. Support piping using supports and methods in accordance with NFPA 13.
  - 3. Install seismic restraints for extinguishing-agent piping systems.
  - 4. Install control panels, detection system components, alarms, and accessories, in accordance with requirements listed in NFPA 2001, Section "Detection, Actuation, and Control Systems," as required for supervised system application.

### 3.4 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance.

### 3.5 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

- E. Connect electrical devices to control panel and to building's fire-alarm system. Electrical power, wiring, and devices are specified in Section 284621.11 "Addressable Fire-Alarm Systems" or Section 284621.13 "Conventional Fire-Alarm Systems."

### 3.6 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

### 3.7 IDENTIFICATION

- A. Identify system components and equipment. Comply with requirements for identification specified in Section 210553 "Identification for Fire-Suppression Piping and Equipment."
- B. Identify piping, extinguishing-agent containers, other equipment, and panels in accordance with NFPA 2001.
- C. Install signs at entry doors for protected areas to warn occupants that they are entering a room protected with a clean-agent fire-extinguishing system.
- D. Install signs at entry doors to advise persons outside the room the meaning of horn(s), bell(s), and strobe light(s) outside the protected space.

### 3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections with the assistance of a factory-authorized service representative.
- D. Tests and Inspections:
  - 1. After installing clean-agent fire-extinguishing system and after electrical circuitry has been energized, test for compliance in accordance with requirements listed in NFPA 2001, Section "Approval of Installation."
  - 2. Clean-agent fire-extinguishing system and associated protected enclosure will be considered defective if either does not pass required tests and inspections.
  - 3. Prepare test and inspection reports in accordance with requirements listed in NFPA 2001, Section "Installation Acceptance."

### 3.9 CLEANING

- A. Each pipe section shall be cleaned internally after preparation and before assembly by means of swabbing, using a suitable nonflammable cleaner. Pipe network shall be free of particulate matter and oil residue before installing nozzles or discharge devices.

### 3.10 OPERATIONAL CONDITION SYSTEM FILLING

#### A. Preparation:

1. Verify that clean-agent fire-extinguishing system and protected enclosure have passed all required tests and inspections in accordance with NFPA 2001.
2. Verify that clean-agent fire-extinguishing piping system installation is completed and cleaned.
3. Verify complete enclosure integrity.
4. Verify operation of ventilation and exhaust systems.

#### B. Filling Procedures:

1. Fill clean-agent fire-extinguishing containers with extinguishing agent, and pressurize to indicated charging pressure.
2. Install filled containers.
3. Energize circuits.
4. Adjust operating controls.

### 3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain clean-agent fire-extinguishing systems.

END OF SECTION 21 22 00

## SECTION 21 31 13

### ELECTRIC-DRIVE, CENTRIFUGAL FIRE PUMPS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section Includes:
  - 1. Horizontally mounted, single-stage, split-case fire pumps.
  - 2. Fire-pump accessories and specialties.
  - 3. Flowmeter systems.
  - 4. Grout.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For fire pumps, motor drivers, and fire-pump accessories and specialties.
  - 1. Include plans, elevations, sections, and mounting and attachment details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.

##### 1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For fire pumps, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.



3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Product Certificates: For each type of fire pump, from manufacturer.
  - C. Source quality-control reports.
  - D. Field quality-control reports.
- 1.6 CLOSEOUT SUBMITTALS
- A. Operation and Maintenance Data: For fire pumps to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Comply with NFPA 20.
- B. Seismic Performance: Fire pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  2. Component Importance Factor: 1.5.
- C. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig (1200 kPa) minimum unless higher pressure rating is indicated.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

### 2.2 GENERAL REQUIREMENTS FOR CENTRIFUGAL FIRE PUMPS

- A. Description: Factory-assembled and -tested fire-pump and driver unit.
- B. Base: Fabricated and attached to fire-pump and driver unit, with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
- C. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

### 2.3 HORIZONTALLY MOUNTED, SINGLE-STAGE, SPLIT-CASE FIRE PUMPS

- A. Pump:
  1. Standard: UL 448, for split-case pumps for fire service.
  2. Casing: Axially split case, cast iron, with ASME B16.1 pipe-flange connections.

3. Impeller: Double suction, cast bronze, statically and dynamically balanced, and keyed to shaft.
  4. Wear Rings: Replaceable bronze.
  5. Shaft and Sleeve: Alloy steel shaft with bronze sleeve.
    - a. Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
    - b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
  6. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.
- B. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
- C. Driver:
1. Standard: UL 1004A.
  2. Type: Electric motor; NEMA MG 1, polyphase Design B.
- D. Capacities and Characteristics:
1. Rated Capacity: <Insert gpm (L/minute)>.
  2. Total Rated Head: <Insert feet or psig (kPa)>.
  3. Inlet Flange: Class 125 [Class 250] <Insert class>.
  4. Outlet Flange: Class 125 [Class 250] <Insert class>.
  5. Suction Head Available at Pump: <Insert feet (m)>.
  6. Motor Horsepower: <Insert number> hp.
  7. Motor Speed: <Insert number> rpm.
  8. Electrical Characteristics:
    - a. Volts: [208] [230] [460] <Insert number> V.
    - b. Phase: Three.
    - c. Hertz: 60.
    - d. Full-Load Amperes: <Insert number> A.
    - e. Minimum Circuit Ampacity: <Insert number> A.
    - f. Maximum Overcurrent Protection: <Insert number> A.
  9. Pump-Start, Pressure-Switch Setting: <Insert psig (kPa)>.
  10. Pump-Stop, Pressure-Switch Setting: <Insert psig (kPa)>.
  11. Rotation [Clockwise] [Counterclockwise].

## 2.4 FIRE-PUMP ACCESSORIES AND SPECIALTIES

- A. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.
- B. Circulation Relief Valves: UL 1478, brass, spring loaded; for installation in pump discharge piping.
- C. Relief Valves:
  1. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.
- D. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.

- E. Outlet Fitting: Concentric tapered reducer at pump discharge outlet.
- F. Discharge Cone: Closed or open type.
- G. Hose Valve Manifold Assembly:
  - 1. Standard: Comply with requirements in NFPA 20.
  - 2. Header Pipe: ASTM A53/A53M, Schedule 40, galvanized steel, with ends threaded according to ASME B1.20.1.
  - 3. Header Pipe Fittings: ASME B16.4, galvanized cast-iron threaded fittings.
  - 4. Automatic Drain Valve: UL 1726.
  - 5. Manifold, Flush-Type Body:
    - a. Test Connections: Comply with UL 405; however, provide outlets without clappers instead of inlets.
    - b. Body: Flush type, brass or ductile iron, with number of outlets required by NFPA 20.
    - c. Nipples: ASTM A53/A53M, Schedule 40, galvanized-steel pipe, with ends threaded according to ASME B1.20.1.
    - d. Adapters and Caps with Chain: Brass or bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
    - e. Escutcheon Plate: Brass or bronze; rectangular.
    - f. Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
    - g. Exposed Parts Finish: Polished.
    - h. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."
  - 6. Manifold, Exposed-Type Body:
    - a. Test Connections: Comply with UL 405; however, provide outlets without clappers instead of inlets.
    - b. Body: Exposed type, brass, with number of outlets required by NFPA 20.
    - c. Escutcheon Plate: Brass or bronze; round.
    - d. Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads. Include caps and chains.
    - e. Exposed Parts Finish: Polished.
    - f. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

## 2.5 FLOWMETER SYSTEMS

- A. Description: UL-listed or FM-Approved, fire-pump flowmeter system able to indicate flow to not less than 175 percent of fire-pump rated capacity.
- B. Pressure Rating: 175 psig (1200 kPa) minimum.
- C. Sensor: Annubar probe, orifice plate, or venturi unless otherwise indicated. Sensor size shall match pipe, tubing, flowmeter, and fittings.
- D. Permanently Mounted Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches (115 mm) in diameter. Include bracket or device for wall mounting.
  - 1. Tubing Package: NPS 1/8 or NPS 1/4 (DN 6 or DN 10) soft copper or plastic tubing with copper or brass fittings and valves.

## 2.6 GROUT

- A. Standard: ASTM C1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink and recommended for interior and exterior applications.
- C. Design Mix: 5000-psi (34-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## 2.7 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect fire pumps according to UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."
  - 1. Verification of Performance: Rate fire pumps according to UL 448.
- B. Fire pumps will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine equipment bases and anchorage provisions, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of fire pumps.
- B. Examine roughing-in for fire-suppression piping systems to verify actual locations of piping connections before fire-pump installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.
- B. Equipment Mounting:
  - 1. Install fire pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
  - 2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."
- C. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.

- D. Support piping and pumps separately, so weight of piping does not rest on pumps.
- E. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in Section 211200 "Fire-Suppression Standpipes." And Section 211313 "Wet-Pipe Sprinkler Systems."
- F. Install pressure gages on fire-pump suction and discharge flange pressure-gage tapings. Comply with requirements for pressure gages specified in Section 211200 "Fire-Suppression Standpipes." and Section 211313 "Wet-Pipe Sprinkler Systems."
- G. Install piping hangers and supports, anchors, valves, gages, and equipment supports according to NFPA 20.
- H. Install flowmeters and sensors. Install flowmeter-system components and make connections according to NFPA 20 and manufacturer's written instructions.
- I. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.
- J. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

### 3.3 ALIGNMENT

- A. Align split-case pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.
- B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.
- C. Align piping connections.
- D. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

### 3.4 CONNECTIONS

- A. Comply with requirements for piping and valves specified in Section 211313 "Wet-Pipe Sprinkler Systems." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to pumps and equipment to allow service and maintenance.
- C. Connect relief-valve discharge to drainage piping or point of discharge.
- D. Connect flowmeter-system meters, sensors, and valves to tubing.
- E. Connect fire pumps to their controllers.

### 3.5 IDENTIFICATION

- A. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

### 3.6 FIELD QUALITY CONTROL

- A. Test each fire pump with its controller as a unit. Comply with requirements for electric-motor-driver fire-pump controllers specified in Section 262933 "Controllers for Fire-Pump Drivers."
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
  - 1. After installing components, assemblies, and equipment, including controller, test for compliance with requirements.
  - 2. Test according to NFPA 20 for acceptance and performance testing.
  - 3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to Owner.

### 3.7 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.

### 3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire pumps.

END OF SECTION 21 31 13

## SECTION 22 05 13

### COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

##### 1.4 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
  - 1. Motor controllers.
  - 2. Torque, speed, and horsepower requirements of the load.
  - 3. Ratings and characteristics of supply circuit and required control sequence.
  - 4. Ambient and environmental conditions of installation location.

#### PART 2 - PRODUCTS

##### 2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.

##### 2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.

- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

## 2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Rotor: Random-wound, squirrel cage.
- E. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- F. Temperature Rise: Match insulation rating.
- G. Insulation: Class F.
- H. Code Letter Designation:
  - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
  - 2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
- I. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

## 2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
  - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
  - 2. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
  - 3. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

## 2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
  - 1. Permanent-split capacitor.
  - 2. Split phase.
  - 3. Capacitor start, inductor run.



- 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 22 05 13

## SECTION 22 05 16

### EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section Includes:
  - 1. Packless expansion joints.
  - 2. Grooved-joint expansion joints.
  - 3. Alignment guides and anchors.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Delegated-Design Submittal: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
  - 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
  - 3. Alignment Guide Details: Detail field assembly and attachment to building structure.
  - 4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

##### 1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

##### 1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For expansion joints to include in maintenance manuals.

## 1.7 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

### 2.2 PACKLESS EXPANSION JOINTS

- A. Flexible-Hose Packless Expansion Joints:
  - 1. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
  - 2. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
  - 3. Expansion Joints for Copper Tubing NPS 2 (DN 50) and Smaller: Copper-alloy fittings with solder-joint end connections.
    - a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F (3100 kPa at 21 deg C) and 340 psig at 450 deg F (2340 kPa at 232 deg C) ratings.
  - 4. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Copper-alloy fittings with threaded end connections.
    - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F (2070 kPa at 21 deg C) and 225 psig at 450 deg F (1550 kPa at 232 deg C) ratings.
- B. Metal-Bellows Packless Expansion Joints:
  - 1. Standards: ASTM F1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
  - 2. Type: Circular, corrugated bellows with external tie rods.
  - 3. Minimum Pressure Rating: 150 psig (1035 kPa), unless otherwise indicated.
  - 4. Configuration: Single joint class, unless otherwise indicated.
  - 5. Expansion Joints for Copper Tubing: Single-ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.
    - a. End Connections for Copper Tubing NPS 2 (DN 50) and Smaller: Solder joint.
    - b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): threaded.
    - c. End Connections for Copper Tubing NPS 5 (DN 125) and Larger: Flanged.
- C. Externally Pressurized Metal-Bellows Packless Expansion Joints:

1. Minimum Pressure Rating: 150 psig (1035 kPa), unless otherwise indicated.
  2. Description:
    - a. Totally enclosed, externally pressurized, multi-ply, stainless-steel bellows isolated from fluid flow by an internal pipe sleeve.
    - b. Carbon-steel housing.
    - c. Drain plugs and lifting lug for NPS 3 (DN 80) and larger.
    - d. Bellows shall have operating clearance between the internal pipe sleeves and the external shrouds.
    - e. Joints shall be supplied with a built-in scale to confirm the starting position and operating movement.
    - f. Joint Axial Movement: 4 inches (100 mm) of compression and 1 inch (25 mm) of extension.
  3. End Connection Configuration: Flanged; one raised, fixed and one floating flange.
- D. Rubber Packless Expansion Joints:
1. Standards: ASTM F1123 and FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."
  2. Material: Fabric-reinforced rubber complying with FSA-PSJ-703.
  3. Arch Type: Single arches.
  4. Minimum Pressure Rating for NPS 1-1/2 to NPS 12 (DN 40 to DN 300): 225 psig (1551 kPa) at 170 deg F (77 deg C).
  5. End Connections: Full-faced, integral steel flanges with steel retaining rings.

## 2.3 GROOVED-JOINT EXPANSION JOINTS

- A. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.
- B. Standard: AWWA C606, for grooved joints.
- C. Nipples: Galvanized ASTM A53/A53M, Schedule 40, Type E or S, steel pipe with grooved ends.
- D. Couplings: Five, flexible type for steel-pipe dimensions. Include ferrous housing sections, and bolts and nuts.

## 2.4 ALIGNMENT GUIDES AND ANCHORS

- A. Alignment Guides:
  1. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.
- B. Anchor Materials:
  1. Steel Shapes and Plates: ASTM A36/A36M.
  2. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
  3. Washers: ASTM F844, steel, plain, flat washers.
  4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
    - a. Stud: Threaded, zinc-coated carbon steel.

- b. Expansion Plug: Zinc-coated steel.
  - c. Washer and Nut: Zinc-coated steel.
5. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
- a. Bonding Material: ASTM C881/C881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
  - b. Stud: ASTM A307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
  - c. Washer and Nut: Zinc-coated steel.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION OF EXPANSION JOINTS

- A. Install expansion joints of sizes matching sizes of piping in which they are installed.
- B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
- C. Install rubber packless expansion joints according to FSA-PSJ-703.
- D. Install grooved-joint expansion joints to grooved-end steel piping.

#### 3.2 INSTALLATION OF PIPE LOOP AND SWING CONNECTIONS

- A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

#### 3.3 INSTALLATION OF ALIGNMENT-GUIDES AND ANCHORS

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install one guide on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- C. Attach guides to pipe, and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
  - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U bolts bolted to anchor.

- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
  - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
  - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
  
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 22 05 16

## SECTION 22 05 17

### SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section Includes:
  - 1. Sleeves.
  - 2. Grout.
  - 3. Silicone sealants.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

##### 1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

#### PART 2 - PRODUCTS

##### 2.1 SLEEVES

- A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.
- B. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, anticorrosion coated or galvanized, with plain ends and integral welded waterstop collar.
- C. Galvanized-Steel Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

- D. PVC Pipe Sleeves: ASTM D1785, Schedule 40.
- E. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

## 2.2 GROUT

- A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## 2.3 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, Use NT.
- B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.
- C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

## PART 3 - EXECUTION

### 3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.
  - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
  - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
  - 2. Cut sleeves to length for mounting flush with both surfaces.



- a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.
  3. Using grout or silicone sealant, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
  1. Cut sleeves to length for mounting flush with both surfaces.
  2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
  3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

### 3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
  1. Concrete Slabs above Grade:
    - a. Piping Smaller Than NPS 6 (DN 150): Steel pipe sleeves.
  2. Interior Partitions:
    - a. Piping Smaller Than NPS 6 (DN 150): Steel pipe sleeves.

END OF SECTION 22 05 17

## SECTION 22 05 18

### ESCUTCHEONS FOR PLUMBING PIPING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section Includes:
  - 1. Escutcheons.
  - 2. Floor plates.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

#### PART 2 - PRODUCTS

##### 2.1 ESCUTCHEONS

- A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.
- C. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- D. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.
- E. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
- F. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed and exposed-rivet hinge; and spring-clip fasteners.

## 2.2 FLOOR PLATES

- A. Split Floor Plates: Cast brass with concealed hinge.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
  - 1. Escutcheons for New Piping:
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
    - b. Chrome-Plated Piping: One-piece steel with polished, chrome-plated finish.
    - c. Insulated Piping: One-piece steel with polished, chrome-plated finish.
    - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
    - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
    - f. Bare Piping in Unfinished Service Spaces: One-piece steel with polished, chrome-plated finish.
    - g. Bare Piping in Equipment Rooms: One-piece steel with polished, chrome-plated finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
  - 1. New Piping: One-piece, floor plate.

### 3.2 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 22 05 18

## SECTION 22 05 19

### METERS AND GAGES FOR PLUMBING PIPING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

###### A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Filled-system thermometers.
3. Liquid-in-glass thermometers.
4. Light-activated thermometers.
5. Thermowells.
6. Dial-type pressure gages.
7. Gage attachments.
8. Test plugs.
9. Test-plug kits.
10. Sight flow indicators.

###### B. Related Requirements:

1. Section 221513 "General-Service Compressed Air Piping" for compressed air gages.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

##### 1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gage.

##### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 BIMETALLIC-ACTUATED THERMOMETERS

- A. Standard: ASME B40.200.
- B. Case: Liquid-filled type(s); stainless steel with 3-inch (76-mm) nominal diameter.
- C. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F (deg C).
- D. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.
- E. Connector Size: 1/2 inch (13 mm), with ASME B1.1 screw threads.
- F. Stem: 0.25 or 0.375 inch (6.4 or 9.4 mm) in diameter; stainless steel.
- G. Window: Plain glass.
- H. Ring: Stainless steel.
- I. Element: Bimetal coil.
- J. Pointer: Dark-colored metal.
- K. Accuracy: Plus or minus 1 percent of scale range.

### 2.2 FILLED-SYSTEM THERMOMETERS

- A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
  - 1. Standard: ASME B40.200.
  - 2. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch (114-mm) nominal diameter.
  - 3. Element: Bourdon tube or other type of pressure element.
  - 4. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.
  - 5. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
  - 6. Pointer: Dark-colored metal.
  - 7. Window: Glass.
  - 8. Ring: Metal.
  - 9. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
  - 10. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
    - a. Design for Thermowell Installation: Bare stem.
  - 11. Accuracy: Plus or minus 1 percent of scale range.
- B. Direct-Mounted, Plastic-Case, Vapor-Actuated Thermometers:
  - 1. Standard: ASME B40.200.
  - 2. Case: Sealed type, plastic; 4-1/2-inch (114-mm) nominal diameter.
  - 3. Element: Bourdon tube or other type of pressure element.

4. Movement: Mechanical, with link to pressure element and connection to pointer.
  5. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
  6. Pointer: Dark-colored metal.
  7. Window: Glass.
  8. Ring: Metal.
  9. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
  10. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
    - a. Design for Thermowell Installation: Bare stem.
  11. Accuracy: Plus or minus 1 percent of scale range.
- C. Remote-Mounted, Metal-Case, Vapor-Actuated Thermometers:
1. Standard: ASME B40.200.
  2. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch (114-mm) nominal diameter with flange and holes for panel mounting.
  3. Element: Bourdon tube or other type of pressure element.
  4. Movement: Mechanical, with link to pressure element and connection to pointer.
  5. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
  6. Pointer: Dark-colored metal.
  7. Window: Glass.
  8. Ring: Metal.
  9. Connector Type(s): Union joint; with ASME B1.1 screw threads.
  10. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
    - a. Design for Thermowell Installation: Bare stem.
  11. Accuracy: Plus or minus 1 percent of scale range.
- D. Remote-Mounted, Plastic-Case, Vapor-Actuated Thermometers:
1. Standard: ASME B40.200.
  2. Case: Sealed type, plastic; 4-1/2-inch (114-mm) nominal diameter with flange and holes for panel mounting.
  3. Element: Bourdon tube or other type of pressure element.
  4. Movement: Mechanical, with link to pressure element and connection to pointer.
  5. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
  6. Pointer: Dark-colored metal.
  7. Window: Glass.
  8. Ring: Metal.
  9. Connector Type(s): Union joint, threaded; with ASME B1.1 screw threads.
  10. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
    - a. Design for Thermowell Installation: Bare stem.
  11. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

## 2.3 LIQUID-IN-GLASS THERMOMETERS

- A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.
  2. Case: Cast aluminum; 6-inch (152-mm) nominal size.
  3. Case Form: Back angle unless otherwise indicated.
  4. Tube: Glass with magnifying lens and blue organic liquid.
  5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
  6. Window: Glass or plastic.
  7. Stem: Aluminum or brass and of length to suit installation.
    - a. Design for Thermowell Installation: Bare stem.
  8. Connector: 3/4 inch (19 mm), with ASME B1.1 screw threads.
  9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
- B. Plastic-Case, Compact-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.
  2. Case: Plastic; 6-inch (152-mm) nominal size.
  3. Case Form: Back angle unless otherwise indicated.
  4. Tube: Glass with magnifying lens and blue organic liquid.
  5. Tube Background: Nonreflective with permanently etched scale markings graduated in deg F (deg C).
  6. Window: Glass or plastic.
  7. Stem: Aluminum or brass and of length to suit installation.
    - a. Design for Thermowell Installation: Bare stem.
  8. Connector: 3/4 inch (19 mm), with ASME B1.1 screw threads.
  9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
- C. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.
  2. Case: Cast aluminum; 7-inch (178-mm) nominal size unless otherwise indicated.
  3. Case Form: Adjustable angle unless otherwise indicated.
  4. Tube: Glass with magnifying lens and blue organic liquid.
  5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
  6. Window: Glass
  7. Stem: Aluminum and of length to suit installation.
    - a. Design for Thermowell Installation: Bare stem.
  8. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
  9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
- D. Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.
  2. Case: Plastic; 7-inch (178-mm) nominal size unless otherwise indicated.
  3. Case Form: Adjustable angle unless otherwise indicated.
  4. Tube: Glass with magnifying lens and blue organic liquid.

5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
6. Window: Glass.
7. Stem: Aluminum, brass, or stainless steel and of length to suit installation.
  - a. Design for Thermowell Installation: Bare stem.
8. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

## 2.4 THERMOWELLS

### A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1 (DN 15, DN 20, or NPS 25), ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

### B. Heat-Transfer Medium: Mixture of graphite and glycerin.

## 2.5 PRESSURE GAGES

### A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.
2. Case: Liquid-filled type(s); cast aluminum or drawn steel; 4-1/2-inch (114-mm) nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Metal.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

### B. Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.
2. Case: Sealed type; 4-1/2-inch (114-mm) nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.



4. Pressure Connection: Brass, with NPS 1/4 (DN 8) ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

C. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.
2. Case: Liquid-filled type; cast aluminum or drawn steel; 4-1/2-inch (114-mm) nominal diameter with flange and holes for panel mounting.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Metal.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

D. Remote-Mounted, Plastic-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.
2. Case: Sealed type; 4-1/2-inch (114-mm) nominal diameter with flange and holes for panel mounting.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

## 2.6 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass ball, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads.

## 2.7 TEST PLUGS

- A. Description: Test-station fitting made for insertion into piping tee fitting.
- B. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- C. Thread Size: NPS 1/4 (DN 8), ASME B1.20.1 pipe thread.

- D. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).
- E. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

## 2.8 TEST-PLUG KITS

- A. Furnish one test-plug kit(s) containing one thermometer, one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
- B. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F (minus 4 to plus 52 deg C).
- C. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- (51- to 76-mm-) diameter dial and probe. Dial range shall be at least 0 to 200 psig (0 to 1380 kPa).
- D. Carrying Case: Metal or plastic, with formed instrument padding.

## 2.9 SIGHT FLOW INDICATORS

- A. Description: Piping inline-installation device for visual verification of flow.
- B. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
- C. Minimum Pressure Rating: 125 psig (860 kPa).
- D. Minimum Temperature Rating: 200 deg F (93 deg C).
- E. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
- F. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install thermowells with socket extending a minimum of 2 inches (51 mm) into fluid and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
- G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- H. Install remote-mounted pressure gages on panel.
- I. Install valve and snubber in piping for each pressure gage for fluids.

### 3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

### 3.3 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.

### 3.4 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C).
- B. Scale Range for Domestic Recirculating and Hot-Water Piping: 0 to 250 deg F (0 to 150 deg C).

### 3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Water Piping: 0 to 100 psi (0 to 600 kPa).

END OF SECTION 22 05 19

SECTION 22 05 23.12

BALL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

- A. Section Includes:
  - 1. Brass ball valves.
  - 2. Bronze ball valves.

1.4 DEFINITIONS

- A. CWP: Cold working pressure.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
  - 1. Certification that products comply with NSF 61 and NSF 372.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads, flange faces, and soldered ends.
  - 3. Set ball valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
  - 1. Maintain valve end protection.
  - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
  - 1. ASME B1.20.1 for threads for threaded end valves.
  - 2. ASME B16.1 for flanges on iron valves.
  - 3. ASME B16.5 for flanges on steel valves.
  - 4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
  - 5. ASME B16.18 for solder-joint connections.
  - 6. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.
- D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. Valve Actuator Types:
  - 1. Gear Actuator: For quarter-turn valves NPS 4 (DN 100) and larger.
  - 2. Handlever: For quarter-turn valves smaller than NPS 4 (DN 100).
- H. Valves in Insulated Piping:
  - 1. Include 2-inch (50-mm) stem extensions.
  - 2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
  - 3. Memory stops that are fully adjustable after insulation is applied.

### 2.2 BRASS BALL VALVES

- A. Brass Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim, Threaded or Soldered Ends:
  - 1. Description:
    - a. Standard: MSS SP-110 or MSS SP-145.
    - b. CWP Rating: 600 psig (4140 kPa).
    - c. Body Design: Two piece.
    - d. Body Material: Forged brass.
    - e. Ends: Threaded and soldered.

- f. Seats: PTFE.
- g. Stem: Stainless steel.
- h. Ball: Stainless steel, vented.
- i. Port: Full.

B. Brass Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim, Press Ends:

1. Description:

- a. Standard: MSS SP-110 or MSS SP-145.
- b. CWP Rating: Minimum 200 psig (1380 kPa).
- c. Body Design: Two piece.
- d. Body Material: Forged brass.
- e. Ends: Press.
- f. Press Ends Connections Rating: Minimum 200 psig (1380 kPa).
- g. Seats: PTFE or RPTFE.
- h. Stem: Stainless steel.
- i. Ball: Stainless steel, vented.
- j. Port: Full.
- k. O-Ring Seal: Buna-N or EPDM.

C. Brass Ball Valves, Three-Piece with Full Port and Stainless-Steel Trim:

1. Description:

- a. Standard: MSS SP-110.
- b. CWP Rating: 600 psig (4140 kPa).
- c. Body Design: Three piece.
- d. Body Material: Forged brass.
- e. Ends: Threaded and soldered.
- f. Seats: PTFE.
- g. Stem: Stainless steel.
- h. Ball: Stainless steel, vented.
- i. Port: Full.

## 2.3 BRONZE BALL VALVES

A. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:

1. Description:

- a. Standard: MSS SP-110 or MSS-145.
- b. CWP Rating: 600 psig (4140 kPa).
- c. Body Design: Two piece.
- d. Body Material: Bronze.
- e. Ends: Threaded or soldered.
- f. Seats: PTFE.
- g. Stem: Stainless steel.
- h. Ball: Stainless steel, vented.
- i. Port: Full.

B. Bronze Ball Valves, Three-Piece with Full Port and Stainless-Steel Trim:

1. Description:

- a. Standard: MSS SP-110.
- b. CWP Rating: 600 psig (4140 kPa).
- c. Body Design: Three piece.

- d. Body Material: Bronze.
  - e. Ends: Threaded.
  - f. Seats: PTFE.
  - g. Stem: Stainless steel.
  - h. Ball: Stainless steel, vented.
  - i. Port: Full.
  - j. Stem: Stainless steel.
- C. Bronze Ball Valves, Two-Piece, Safety-Exhaust:
1. Description:
    - a. Standard: MSS SP-110.
    - b. CWP Rating: 600 psig (4140 kPa).
    - c. Body Design: Two piece.
    - d. Body Material: Bronze, ASTM B584, Alloy C844.
    - e. Ends: Threaded.
    - f. Seats: PTFE.
    - g. Stem: Stainless steel.
    - h. Ball: Stainless steel, with exhaust vent opening for pneumatic applications.
    - i. Port: Full.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

### 3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.

- E. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

### 3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. Select valves with the following end connections:
  - 1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.
  - 2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
  - 3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.

### 3.4 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG (1035 kPa) OR LESS)

- A. Pipe NPS 2 (DN 50) and Smaller:
  - 1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
  - 2. Brass ball valves, two-piece with full port and stainless steel trim.
  - 3. Bronze ball valves, two-piece with full port and stainless steel trim.

### 3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 (DN 50) and Smaller:
  - 1. Brass ball valves, two-piece with full port and stainless steel trim. Provide with threaded joint ends.
  - 2. Bronze ball valves, two-piece with full port and stainless steel trim. Provide with threaded joint ends.

END OF SECTION 22 05 23.12



SECTION 22 05 23.13

BUTTERFLY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

- A. Section Includes:
  - 1. Iron, single-flange (lug-type) butterfly valves.
  - 2. Chainwheels.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene-diene terpolymer rubber.
- C. NBR: ABS, Buna-N, or nitrile butadiene rubber.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads, flange faces, grooves, and weld ends.
  - 3. Set butterfly valves closed or slightly open.
- B. Use the following precautions during storage:
  - 1. Maintain valve end protection.
  - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

## PART 2 - PRODUCTS

### 2.1 SOURCE LIMITATIONS

- A. Obtain each type of valve from single source from single manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

#### A. Standards:

1. Domestic water piping specialties intended to convey or dispense water for human consumption must comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or must be certified to be in compliance with NSF 61 and NSF 372 (by an ANSI-accredited third-party certification body) that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

#### B. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.
2. ASME B16.5 for flanges on steel valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B31.9 for building services valves.

#### C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

#### D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

#### E. Valve Sizes: Same as upstream piping unless otherwise indicated.

#### F. Valve Actuator Types:

1. Gear Actuator: For valves NPS 8 (DN 200) and larger.
2. Hand lever: For valves NPS 6 (DN 150) and smaller.
3. Chainwheel: Device for attachment to gear, handlever, or stem; of size and with chain for mounting height, according to "Installation of Valves" Article.

#### G. Valves in Insulated Piping: Provide 2-inch (50-mm) extended neck stems.

### 2.3 IRON, SINGLE-FLANGE (LUG-TYPE) BUTTERFLY VALVES

#### A. Iron, Single-Flange (Lug-Type) Butterfly Valves with Stainless Steel Disc:

1. Standard: MSS SP-67, Type I.
2. CWP Rating, NPS 12 (DN 300) and Smaller: 250 psig (1725 kPa).
3. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
4. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
5. Seat: EPDM
6. Stem: One- or two-piece stainless steel.
7. Disc: Stainless steel.

## 2.4 CHAINWHEELS

- A. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to handwheels.
  - 1. Sprocket Rim with Chain Guides: Ductile iron of type and size required for valve.
  - 2. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine mating flange faces for damage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- D. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

### 3.2 INSTALLATION OF VALVES

- A. Install valves with unions or flanges at each piece of equipment arranged to allow space for service, maintenance, and equipment removal without system shutdown.
- B. Provide support to piping adjacent to valves such that no force is imposed upon valves.
- C. Locate valves for easy access.
- D. Install valves in horizontal piping with stem at or above center of pipe.
- E. Install valves in position to allow full valve actuation movement.
- F. Install chainwheels on actuators for butterfly valves NPS 4 (DN 100) and larger and more than 96 inches (2400 mm) above floor. Extend chains to 60 inches (1520 mm) above finished floor.
- G. Valve Tags: Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

### 3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. If leakage cannot be repaired, replace valves.

3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Iron, Single-Flange (Lug-Type) Butterfly Valves: 200 CWP, EPDM seat, and stainless steel disc.

END OF SECTION 22 05 23.13

SECTION 22 05 23.14

CHECK VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

- A. Section Includes:
  - 1. Bronze, swing check valves.
  - 2. Iron, swing check valves.
  - 3. Iron, center-guided check valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene-diene terpolymer.
- C. NBR: Nitrile butadiene rubber (also known as Buna-N).

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads, flange faces, grooves, press connections, and weld ends.
  - 3. Set check valves in either closed or open position.
- B. Use the following precautions during storage:
  - 1. Maintain valve end protection.
  - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use stems or other components as lifting or rigging points unless specifically indicated for this purpose in manufacturer's instructions.

## PART 2 - PRODUCTS

- A. Obtain each type of valve from single source from single manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Standards:

- 1. Domestic water piping check valves intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of authorities having jurisdiction, and NSF 61/NSF 372, or to be certified in compliance with NSF 61/NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

- B. ASME Compliance:

- 1. ASME B1.20.1 for threads for threaded end valves.
- 2. ASME B16.1 for flanges on iron valves.
- 3. ASME B16.5 for flanges for metric standard piping.
- 4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
- 5. ASME B16.18 for cast-copper solder joint.
- 6. ASME B16.22 for wrought copper solder joint.
- 7. ASME B16.51 for press joint.
- 8. ASME B31.9 for building services piping valves.

- C. AWWA Compliance: Comply with AWWA C606 for groove-end connections.

- D. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are unacceptable.

- E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

- F. Valve Sizes: Same as upstream piping unless otherwise indicated.

- G. Valve Bypass and Drain Connections: MSS SP-45.

### 2.3 BRONZE SWING CHECK VALVES

- A. Bronze, Swing Check Valves with Bronze Disc, Class 150:

- 1. Description:
  - a. Standard: MSS SP-80, Type 3.
  - b. CWP Rating: 300 psig (2070 kPa).
  - c. Body Design: Horizontal flow.
  - d. Body Material: ASTM B62, bronze.
  - e. Ends: Threaded or soldered. See valve schedule articles.
  - f. Disc: Bronze.

- B. Bronze, Swing Check Valves with Nonmetallic Disc, Class 150:

- 1. Description:

- a. Standard: MSS SP-80, Type 4.
- b. CWP Rating: 300 psig (2070 kPa).
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B62, bronze.
- e. Ends: Threaded or soldered. See valve schedule articles.
- f. Disc: PTFE.

C. Bronze, Swing Check Valves, Press Ends:

- 1. Description:
  - a. Standard: MSS SP-80 and MSS SP-139.
  - b. CWP Rating: Minimum 200 psig (1380 kPa).
  - c. Body Design: Horizontal flow.
  - d. Body Material: ASTM B584, bronze.
  - e. Ends: Press.
  - f. Press Ends Connection Rating: Minimum 200 psig (1380 kPa).
  - g. Disc: Brass or bronze.

## 2.4 IRON, SWING CHECK VALVES

A. Iron, Swing Check Valves with Nonmetallic-to-Metal Seats, Class 125:

- 1. Description:
  - a. Standard: MSS SP-71, Type I.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Design: Clear or full waterway.
  - d. Body Material: ASTM A126, gray iron with bolted bonnet.
  - e. Ends: Flange or threaded. See valve schedule articles.
  - f. Trim: Composition.
  - g. Seat Ring: Bronze.
  - h. Disc Holder: Bronze.
  - i. Disc: PTFE.
  - j. Gasket: Asbestos free.

B. Iron, Swing Check Valves with Metal Seats, Class 250:

- 1. Description:
  - a. Standard: MSS SP-71, Type I.
  - b. CWP Rating: 500 psig (3450 kPa).
  - c. Body Design: Clear or full waterway.
  - d. Body Material: ASTM A126, gray iron with bolted bonnet.
  - e. Ends: Flange or threaded. See valve schedule articles.
  - f. Trim: Bronze.
  - g. Gasket: Asbestos free.

## 2.5 IRON, SWING CHECK VALVES WITH CLOSURE CONTROL

A. Iron, Swing Check Valves with Lever- and Spring-Closure Control, Class 125:

- 1. Description:
  - a. Standard: MSS SP-71, Type I.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Design: Clear or full waterway.

- d. Body Material: ASTM A126, gray iron with bolted bonnet.
- e. Ends: Flange or threaded. See valve schedule articles.
- f. Trim: Bronze.
- g. Gasket: Asbestos free.
- h. Closure Control: Factory-installed exterior lever and weight.

B. Iron, Swing Check Valves with Lever and Weight-Closure Control, Class 125:

1. Description:

- a. Standard: MSS SP-71, Type I.
- b. CWP Rating: 200 psig (1380 kPa).
- c. Body Design: Clear or full waterway.
- d. Body Material: ASTM A126, gray iron with bolted bonnet.
- e. Ends: Flange or threaded. See valve schedule articles.
- f. Trim: Bronze.
- g. Gasket: Asbestos free.
- h. Closure Control: Factory-installed exterior lever and weight.

## 2.6 IRON, CENTER-GUIDED, SPRING-LOADED CHECK VALVES

A. Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat, Class 250:

1. Description:

- a. Standard: MSS SP-125.
- b. CWP Rating: 400 psig (2760 kPa).
- c. Body Material: ASTM A126, gray iron.
- d. Style: Compact wafer, spring loaded.
- e. Seat: EPDM.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Examine press fittings to verify they have been properly press.
- F. Do not attempt to repair defective valves; replace with new valves.



### 3.2 INSTALLATION OF VALVES

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Provide support of piping adjacent to valves such that no force is imposed upon valves.
- C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.
- D. Install valves so that stems are horizontal or slope upward from centerline of pipe.
- E. Install valves in position that does not project into aisles or block access to other equipment.
- F. Install valves in position to allow full stem and manual operator movement.
- G. Verify that joints of each valve have been properly installed and sealed to assure there is no leakage or damage.
- H. Check Valves: Install check valves for proper direction of flow.
  - 1. Swing Check Valves: In horizontal position with hinge pin level.
  - 2. Check Valves: In horizontal or vertical position, between flanges.
  - 3. Lift Check Valves: With stem upright and plumb.
- I. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
- J. Adhere to manufacturer's installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.

### 3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

### 3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
  - 1. Pump-Discharge Check Valves:
    - a. NPS 2 (DN 50) and Smaller: Bronze, swing check valves with bronze disc.
    - b. NPS 2-1/2 (DN 65) and Larger for Domestic Water: Iron, swing check valves with lever and weight or spring; or iron, center-guided, resilient-seat check valves.
    - c. NPS 2-1/2 (DN 65) and Larger for Sanitary Waste and Storm Drainage: Iron, swing check valves with lever and weight or spring.
- B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- C. End Connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded, soldered, or press-end connections.
2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flange or threaded.
3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flange.
4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded.
5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flange or threaded.
6. For Steel Piping, NPS 5 (DN 125) and Larger: Flange.
7. For Groove-End Copper Tubing and Steel Piping: Groove.

### 3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

#### A. Pipe NPS 2 (DN 50) and Smaller:

1. Bronze, swing check valves with bronze disc, Class 150, with soldered or threaded end connections.

#### B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Iron, swing check valves with nonmetallic-to-metal seats, Class 250, with threaded or flange end connections.

END OF SECTION 22 05 23.14

SECTION 22 05 23.15

GATE VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

- A. Section Includes:

- 1. Bronze gate valves.
- 2. Iron gate valves.
- 3. Chainwheels.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene-diene terpolymer.
- C. NRS: Nonrising stem.
- D. OS&Y: Outside screw and yoke.
- E. RS: Rising stem.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads, flange faces, grooves, press connections, and weld ends.
  - 3. Set gate valves closed to prevent rattling.
- B. Use the following precautions during storage:
  - 1. Maintain valve end protection.

2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels, stems, or other components as lifting or rigging points unless specifically indicated for this purpose in manufacturer's instructions.

## PART 2 - PRODUCTS

### 2.1 SOURCE LIMITATIONS

- A. Obtain each type of valve from single source from single manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

A. Standards:

1. Domestic water piping check valves intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of authorities having jurisdiction, and NSF 61/NSF 372, or to be certified in compliance with NSF 61/NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on metric standard piping.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for cast-copper solder joint.
6. ASME B16.22 for wrought copper solder joint.
7. ASME B16.51 for press joint.
8. ASME B31.9 for building services piping valves.

C. AWWA Compliance: AWWA C606 for groove-end connections.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions.

G. Valve Bypass and Drain Connections: MSS SP-45.

### 2.3 BRONZE GATE VALVES

A. Bronze Gate Valves, NRS, Class 150:

1. Description:

- a. Standard: MSS SP-80, Type 1.
- b. CWP Rating: 300 psig (2070 kPa).
- c. Body Material: Bronze with integral seat and union-ring bonnet.
- d. Ends: Threaded.
- e. Stem: Bronze.
- f. Disc: Solid wedge; bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron, bronze, or aluminum.

## 2.4 IRON GATE VALVES

### A. Iron Gate Valves, OS&Y, Class 250:

#### 1. Description:

- a. Standard: MSS SP-70, Type I.
- b. CWP Rating: 500 psig (3450 kPa).
- c. Body Material: Gray iron with bolted bonnet.
- d. Ends: Flange.
- e. Trim: Bronze.
- f. Disc: Solid wedge.
- g. Packing and Gasket: Asbestos free.

## 2.5 CHAINWHEELS

### A. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to hand wheels.

- 1. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
- 2. Chain: Hot-dip galvanized steel of size required to fit sprocket rim.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Examine press joint surfaces. Verify they are clean and free from dents and burrs, and that o-ring seals are in place and undamaged.
- F. Do not attempt to repair defective valves; replace with new valves.

### 3.2 INSTALLATION OF VALVES

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Provide support of piping adjacent to valves such that no force is imposed upon valves.
- C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.
- D. Install valves so that stems are horizontal or slope upward from centerline of pipe.
- E. Install valves in position that does not project into aisles or block access to other equipment.
- F. Install valves in position to allow full stem and manual operator movement.
- G. Verify that joints of each valve have been properly installed and sealed to assure there is no leakage or damage.
- H. Install chainwheels on manual operators for gate valves NPS 4 (DN 100) and larger and more than 96 inches (2400 mm) above floor. Extend chains to 60 inches (1520 mm) above finished floor.
- I. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
- J. Adhere to manufacturer's installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.

### 3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

### 3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. Use gate valves for shutoff service only.
- B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- C. End Connections:
  - 1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded, soldered, or press-end connections.
  - 2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flange or threaded.
  - 3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flange.
  - 4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded.
  - 5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flange or threaded.
  - 6. For Steel Piping, NPS 5 (DN 125) and Larger: Flange.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Bronze gate valves, NRS, Class 150 with soldered ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger: Iron gate valves, OS&Y, Class 250 with flange ends.

END OF SECTION 22 05 23.15

## SECTION 22 05 29

### HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

###### A. Section Includes:

1. Metal pipe hangers and supports.
2. Thermal hanger-shield inserts.
3. Fastener systems.

- B. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Include design calculations for designing trapeze hangers.

#### PART 2 - PRODUCTS

- A. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment.

##### 2.2 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:



1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

## 2.3 THERMAL HANGER-SHIELD INSERTS

- A. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psig (688-kPa) minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psig (688-kPa) minimum compressive strength.
- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

## 2.4 FASTENER SYSTEMS

- A. hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
  1. Indoor Applications: Zinc-coated or steel.
  2. Outdoor Applications: Stainless steel.

## PART 3 - EXECUTION

### 3.1 APPLICATION

- A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

### 3.2 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.
- C. Fastener System Installation:
  - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
  - 2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- E. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- F. Install lateral bracing with pipe hangers and supports to prevent swaying.
- G. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- I. Insulated Piping:
  - 1. Attach clamps and spacers to piping.
    - a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
    - b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
    - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
  - a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
  - a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
  - a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
5. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

### 3.3 METAL FABRICATIONS

- A. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- B. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
  1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  2. Obtain fusion without undercut or overlap.
  3. Remove welding flux immediately.
  4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

### 3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

### 3.5 PAINTING

- A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Section 099123 "Interior Painting."

- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

### 3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports and attachments for general service applications.
- F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal hanger-shield inserts for insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
  - 2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
  - 3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
  - 4. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
  - 5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
  - 6. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
  - 7. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction occurs.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
  - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches (150 mm) for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
  3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
  4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  6. C-Clamps (MSS Type 23): For structural shapes.
  7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
  8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
  9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
  10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
  11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
  12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): 750 lb (340 kg).
    - b. Medium (MSS Type 32): 1500 lb (680 kg).
    - c. Heavy (MSS Type 33): 3000 lb (1360 kg).
  13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
  15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

- N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
  2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
  3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
  4. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    - a. Horizontal (MSS Type 54): Mounted horizontally.
    - b. Vertical (MSS Type 55): Mounted vertically.
    - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- O. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 22 05 29

## SECTION 22 05 48

### VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

###### A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient support.
9. Resilient pipe guides.
10. Elastomeric hangers.
11. Spring hangers.
12. Snubbers.
13. Restraints - rigid type.
14. Restraints - cable type.
15. Restraint accessories.
16. Post-installed concrete anchors.
17. Concrete inserts.
18. Vibration isolation equipment bases.

###### B. Related Requirements:

1. Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" for devices for fire-suppression equipment and systems.
2. Section 230548 "Vibration and Seismic Controls for HVAC" for devices for HVAC equipment and systems.

## 1.4 DEFINITIONS

- A. Designated Seismic System: A plumbing component that requires design in accordance with ASCE/SEI 7, Ch. 13 and for which the Component Importance Factor is greater than 1.0.
- B. IBC: International Building Code.
- C. OSHPD: Office of Statewide Health Planning and Development (for the State of California owned and regulated medical facilities).

## 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
  - 2. Include load rating for each wind-force-restraint fitting and assembly.
  - 3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic restraint component.
  - 4. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by an agency acceptable to authorities having jurisdiction.
  - 5. Annotate to indicate application of each product submitted and compliance with requirements.
  - 6. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Shop Drawings:
  - 1. Detail fabrication and assembly of equipment bases.
  - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal:
  - 1. For each seismic-restraint device, including seismic-restrained mounting, pipe-riser resilient support, snubber, seismic restraint, seismic-restraint accessory, and concrete anchor and insert, that is required by this Section or is indicated on Drawings, submit the following:
    - a. Seismic restraint, and vibration isolator, and isolation base selection: Select vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
    - b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.
    - c. Concrete Anchors and Inserts: Include calculations showing anticipated seismic and wind loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
    - d. Seismic Design Calculations: Submit all input data and loading calculations prepared in "Performance Requirements" Article in "Seismic Design Calculations" Paragraph.



- e. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared in "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.
  - f. Qualified Professional Engineer: All designated-design submittals for seismic calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.
2. Seismic-Restraint Detail Drawing:
    - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
    - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
    - c. Coordinate seismic restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.
  3. Product Listing, Preapproval, and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
  4. All delegated-design submittals for seismic- and wind-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.
  5. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.
  6. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For professional engineer and testing agency.
- C. Welding certificates.
- D. Air-Spring Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent agency.
- E. Field quality-control reports:
- F. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in ASCE/SEI 7-05, ASCE/SEI 7-10, ASCE/SEI 7-16, Paragraph 13.2.2, "Special Certification Requirements for Designated Seismic Systems" for all Designated Seismic Systems identified as such on Drawings or in the Specifications.
  1. Provide equipment manufacturer's written certification for each designated active plumbing seismic device and system, stating that it will remain operable following the

design earthquake. Certification must be based on requirements of ASCE/SEI 7 and AHRI 1270 (AHRI 1271), including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction.

2. Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7-05.
3. Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed professional engineer.

G. Wind-Force Performance Certification: Provide special certification for plumbing components subject to high wind exposure and impact damage and designated on Drawings or in the Specifications to require wind-force performance certification.

1. Provide equipment manufacturer's written certification for each designated plumbing device, stating that it will remain in place and operable following the design wind event and comply with all requirements of authorities having jurisdiction.
2. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.

## 1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-spring isolators and restrained-air-spring isolators to include in operation and maintenance manuals.

## 1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7, and be acceptable to authorities having jurisdiction.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Seismic-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: an agency acceptable to authorities having jurisdiction.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic control system.

1. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7-05.

B. Seismic Design Calculations:

1. Perform calculations to obtain force information necessary to properly select seismic-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7-05 or other seismic calculation method required by authorities having jurisdiction. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is the edition intended as reference throughout the section text.
  - a. Data indicated below to be determined by Delegated-Design Contractor must be obtained by Contractor and must be included in individual component submittal packages.
  - b. Coordinate seismic design calculations with wind-load calculations for equipment mounted outdoors. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.
  - c. Building Occupancy Category: III.
  - d. Building Risk Category: II.
  - e. Building Site Classification: D.
2. Calculation Factors, ASCE/SEI 7-16, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-16 unless otherwise noted.
  - a. Horizontal Seismic Design Force  $F_p$ : Value is to be calculated by Delegated-Design Contractor using Equation 13.3-1. Factors below must be obtained for this calculation.
    - 1)  $S_{DS}$  = Spectral Acceleration: Value applies to all components on Project.
    - 2)  $a_p$  = Component Amplification Factor: See Drawing Schedule for each component.
    - 3)  $I_p$  = Component Importance Factor: See Drawing Schedule for each component.
    - 4)  $W_p$  = Component Operating Weight: For each component. Obtain by Delegated-Design Contractor from each component submittal.
    - 5)  $R_p$  = Component Response Modification Factor: See Drawing Schedule for each component.
    - 6)  $z$  = Height in Structure of Point of Attachment of Component for Base: Determine from Project Drawings for each component by Delegated-Design Contractor. For items at or below the base, "z" shall be taken as zero.
    - 7)  $h$  = Average Roof Height of Structure for Base: Determine from Project Drawings by Delegated-Design Contractor.
  - b. Vertical Seismic Design Force: Calculated by Delegated-Design Contractor using method explained in ASCE/SEI 7-16, Paragraph 13.3.1.2.
  - c. Seismic Relative Displacement  $D_{pl}$ : Calculated by Delegated-Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.2. Factors below must be obtained for this calculation:
    - 1)  $D_p$  = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculated by Delegated-Design Contractor in accordance with ASCE/SEI 7-16, Paragraph 13.3.2.
    - 2)  $I_e$  = Structure Importance Factor: Value applies to all components on Project.
    - 3)  $\delta_{xA}$  = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
    - 4)  $\delta_{yA}$  = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.

- 5)  $\delta_{yB}$  = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
  - 6)  $h_x$  = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
  - 7)  $h_y$  = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
  - 8)  $\Delta_{aA}$  = Allowable Story Drift for Structure A: See Drawing Schedules for each component.
  - 9)  $\Delta_{aB}$  = Allowable Story Drift for Structure B: See Drawing Schedules for each component.
  - 10)  $h_{sx}$  = Story Height Used in the Definition of Allowable Drift  $\Delta_a$ : See Drawings Schedules for each component.
- d. Component Fundamental Period  $T_p$ : Calculated by Delegated-Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.3. Factors below must be obtained for this calculation:
- 1)  $W_p$  = Component Operating Weight: Determined by Contractor from Project Drawings and manufacturer's data.
  - 2)  $g$  = Gravitational Acceleration: 32.17 fps<sup>2</sup> (9.81 m/s<sup>2</sup>).
  - 3)  $K_p$  = Combined Stiffness of the Component, Supports, and Attachments: Determined by delegated-design seismic engineer.
3. Calculation Factors, ASCE/SEI 7-10, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-10 unless otherwise noted.
- a. Horizontal Seismic Design Force  $F_p$ : Calculated by Delegated-Design Contractor by ASCE/SEI 7-10, Equation 13.3-1. Factors below must be obtained for this calculation:
- 1)  $S_{DS}$  = Spectral Acceleration: Value applies to all components on Project.
  - 2)  $a_p$  = Component Amplification Factor: See Drawing Schedule for each component.
  - 3)  $I_p$  = Component Importance Factor: See Drawing Schedule for each component.
  - 4)  $W_p$  = Component Operating Weight: For each component. Obtain by Delegated-Design Contractor from equipment submittal.
  - 5)  $R_p$  = Component Response Modification Factor: See Drawing Schedule for each component.
  - 6)  $z$  = Height in Structure of Point of Attachment of Component for Base: Determined from Project Drawings for each component by Contractor. For items at or below the base, "z" shall be taken as zero.
  - 7)  $h$  = Average Roof Height of Structure for Base: Determine from Project Drawings by Delegated-Design Contractor.
- b. Vertical Seismic Design Force: Calculate by Delegated- Design Contractor using method explained in ASCE/SEI 7-10, Paragraph 13.3.1.
- c. Seismic Relative Displacement  $D_{pi}$ : Calculate by Delegated-Design Contractor using methods explained in ASCE/SEI 7-10, Paragraph 13.3.2. Factors below must be obtained for this calculation:
- 1)  $D_p$  = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculate by Delegated-Design Contractor in accordance with ASCE/SEI 7-10, Paragraph 13.3.2.

- 2)  $I_e$  = Structure Importance Factor: Value applies to all components on Project.
  - 3)  $\delta_{xA}$  = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
  - 4)  $\delta_{yA}$  = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.
  - 5)  $\delta_{yB}$  = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
  - 6)  $h_x$  = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data;
  - 7)  $h_y$  = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
  - 8)  $\Delta_{aA}$  = Allowable Story Drift for Structure A: See Drawing Schedule for each component.
  - 9)  $\Delta_{aB}$  = Allowable Story Drift for Structure B: See Drawing Schedule for each component.
  - 10)  $h_{sx}$  = Story Height Used in the Definition of the Allowable Drift  $\Delta_a$ : See Schedule for each component.
4. Calculation Factors, ASCE/SEI 7-05, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-05 unless otherwise noted.
- a. Horizontal Seismic Design Force  $F_p$ : Calculated by Delegated-Design Contractor by ASCE/SEI 7-05, Equation 13.3-1. Factors below must be obtained for this calculation.
    - 1)  $S_{DS}$  = Spectral Acceleration: Value applies to all components on the project.
    - 2)  $a_p$  = Component Amplification Factor: See Drawing Schedule for each component.
    - 3)  $I_p$  = Component Importance Factor: See Drawing Schedule for each component.
    - 4)  $W_p$  = Component Operating Weight: Obtain by Delegated-Design Contractor for each component from component submittal.
    - 5)  $R_p$  = Component Response Modification Factor: See Drawing Schedule for each component.
    - 6)  $z$  = Height in Structure of Point of Attachment of Component for the Base: Determine by Delegated-Design Contractor for each component from Project Drawings. For items at or below the base, "z" shall be taken as zero.
    - 7)  $h$  = Average Roof Height of Structure for the Base: Determine by Delegated-Design Contractor from Project Drawings.
  - b. Vertical Seismic Design Force: Calculated by Delegated-Design Contractor using method explained in ASCE/SEI 7-05, Paragraph 13.3.1.
  - c. Seismic Relative Displacement  $D_p$ : Calculated by Delegated-Design Contractor using methods explained in ASCE/SEI 7-05, Paragraph 13.3.2. Factors below must be obtained for this calculation:
    - 1)  $\delta_{xA}$  = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
    - 2)  $\delta_{yA}$  = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.
    - 3)  $\delta_{yB}$  = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.

- 4)  $h_x$  = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
- 5)  $h_y$  = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
- 6)  $\Delta_{aA}$  = Allowable Story Drift for Structure A: See Drawing Schedule for each component.
- 7)  $\Delta_{aB}$  = Allowable Story Drift for Structure B: See Drawing Schedule for each component.
- 8)  $h_{sx}$  = Story Height Used in the Definition of the Allowable Drift  $\Delta_a$ : See Drawing Schedule for each component.

C. Wind-Load Design Calculations:

1. Perform calculations to obtain force information necessary to properly select wind-load-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7-05 or other wind-force calculation method required by authorities having jurisdiction. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is intended as referenced throughout the Section Text unless otherwise noted.
  - a. Data indicated below that are specific to individual pieces of equipment must be obtained by Contractor and must be included in individual component submittal packages.
  - b. Coordinate design wind-load calculations with seismic load calculations for equipment requiring both seismic and wind-load reinforcement. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.
2. Design wind pressure "p" for external sidewall-mounted equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30. Perform calculations according to one of the following, as appropriate:
  - a. PART 1: Low-Rise Buildings.
  - b. PART 2: Low-Rise Buildings (Simplified).
  - c. PART 3: Buildings with "h" less than 60 feet (18.3 m).
  - d. PART 4: Buildings with "h" greater than 60 feet (18.3 m) and less than 160 feet (48.8 m).
  - e. PART 5: Open Buildings.
3. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.
  - a. Risk Category:
  - b.  $h$  = Mean Roof Height:
  - c.  $V$  = Basic Wind Speed:
  - d.  $K_d$  = Wind Directionality Factor:
  - e. Exposure Category:
  - f.  $K_{zt}$  = Topographic Factor:
  - g.  $K_e$  = Ground Elevation Factor:
  - h.  $K_z$  = Velocity Pressure Exposure Coefficient (Evaluated at Height z):
  - i.  $K_h$  = Velocity Pressure Exposure Coefficient (Evaluated at Height h):
  - j.  $q_z$  = Velocity Pressure: Value calculated by delegated wind-load design contractor using methods detailed in ASCE/SEI 7-16 Section 26.10.1 or other source approved by authorities having jurisdiction.

- k.  $q_h$  = Velocity Pressure: Value calculated by delegated wind-load design contractor using methods detailed in ASCE/SEI 7-16 Section 26.10.1 or other source approved by authorities having jurisdiction.
  - l.  $G$  = Gust-Effect Factor: 0.85
  - m. Enclosure Classification:
  - n.  $GC_{pi}$  = Internal Pressure Coefficient:
4. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-10, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.
- a. Risk Category:
  - b.  $h$  = Mean Roof Height:
  - c.  $V$  = Basic Wind Speed:
  - d.  $K_d$  = Wind Directionality Factor:
  - e. Exposure Category:
  - f.  $K_{zt}$  = Topographic Factor:
  - g.  $K_z$  = Velocity Pressure Exposure Coefficient (Evaluated at Height  $z$ ):
  - h.  $K_h$  = Velocity Pressure Exposure Coefficient (Evaluated at Height  $h$ ):
  - i.  $q_z$  = Velocity Pressure at Height  $z$ : Value calculated by delegated wind-load design contractor using methods detailed in ASCE/SEI 7-10 Section 26.10.1 or other source approved by authorities having jurisdiction.
  - j.  $q_h$  = Velocity Pressure at Height  $h$ : Value calculated by delegated wind-load design contractor using methods detailed in ASCE/SEI 7-10 Section 26.10.1 or other source approved by authorities having jurisdiction.
  - k.  $G$  = Gust-Effect Factor: 0.85
  - l. Enclosure Classification:
  - m.  $GC_{pi}$  = Internal Pressure Coefficient:
5. Design Wind Force "F" for rooftop equipment and external sidewall-mounted equipment such as louvers is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-05, Ch. 6.
- a.  $I$  = Importance Factor:
  - b.  $h$  = Mean Roof Height:
  - c.  $V$  = Basic Wind Speed:
  - d.  $K_d$  = Wind Directionality Factor:
  - e. Exposure Category:
  - f.  $K_{zt}$  = Topographic Factor:
  - g.  $K_z$  = Velocity Pressure Exposure Coefficient (Evaluated at Height  $z$ ):
  - h.  $K_h$  = Velocity Pressure Exposure Coefficient (Evaluated at Height  $h$ ):
  - i.  $q_z$  = Velocity Pressure at Height  $z$ : Value calculated by delegated wind-load design contractor using methods detailed in ASCE/SEI 7-05 Section 6.5.10 or other source approved by authorities having jurisdiction.
  - j.  $q_h$  = Velocity Pressure at Roof Height  $h$ : Value calculated by delegated wind-load design contractor using methods detailed in ASCE/SEI 7-05 Section 6.5.10 or other source approved by authorities having jurisdiction.
  - k.  $G$  = Gust-Effect Factor: 0.85
  - l.  $GC_{pi}$  = Internal Pressure Coefficient:
  - m.  $GC_p$  = External pressure coefficient:
  - n.  $C_f$  = Force Coefficient: Value determined by delegated wind-load design Contractor from ASCE/SEI 7-05, Figures 6-21 through 6-23 or other source approved by authorities having jurisdiction.
  - o.  $A_r$  = Projected area normal to the wind: except where  $C_f$  is specified for the actual surface area. Value determined by delegated wind-load design contractor from equipment submittal or manufacturer.

D. Consequential Damage: Provide additional seismic and wind-force restraints for suspended plumbing components or anchorage of floor, roof or wall mounted plumbing components as

indicated in ASCE/SEI 7-05 so that failure of a non-essential or essential plumbing component will not cause the failure of any other essential architectural, mechanical or electrical building component.

- E. Fire/Smoke Resistance: Seismic-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.
- F. Component Supports:
  - 1. Load Ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.
  - 2. All component support attachments must comply with force and displacement resistance requirements of ASCE/SEI 7-05 Section 13.6.

## 2.2 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads:
  - 1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
  - 2. Size: Factory or field cut to match requirements of supported equipment.
  - 3. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
  - 4. Surface Pattern: Smooth, ribbed, or waffle pattern.
  - 5. Infused nonwoven cotton or synthetic fibers.
  - 6. Load-bearing metal plates adhered to pads.
  - 7. Sandwich-Core Material: Resilient.
    - a. Surface Pattern: Smooth, ribbed, or waffle pattern.
    - b. Infused nonwoven cotton or synthetic fibers.

## 2.3 ELASTOMERIC ISOLATION MOUNTS

- A. Double-Deflection, Elastomeric Isolation Mounts:
  - 1. Mounting Plates:
    - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
    - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
  - 2. Elastomeric Material: Molded, oil- and water-resistant neoprene rubber, silicone rubber, or other elastomeric material.

## 2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

- A. Restrained Elastomeric Isolation Mounts:
  - 1. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.



- a. Housing: Cast-ductile iron or welded steel.
- b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.5 OPEN-SPRING ISOLATORS

### A. Freestanding, Laterally Stable, Open-Spring Isolators:

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig (3447 kPa).
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

## 2.6 HOUSED-SPRING ISOLATORS

### A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
  - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
  - b. Top housing with attachment and leveling bolt.

## 2.7 RESTRAINED-SPRING ISOLATORS

### A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:

1. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
  - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
  - b. Top plate with threaded mounting holes.
  - c. Internal leveling bolt that acts as blocking during installation.
2. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.

5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

## 2.8 HOUSED-RESTRAINED-SPRING ISOLATORS

### A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:

1. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
  - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
  - b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

## 2.9 PIPE-RISER RESILIENT SUPPORT

### A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-inch- (13-mm-) Thick Neoprene:

1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
2. Maximum Load Per Support: 500 psig (3447 KPa) on isolation material providing equal isolation in all directions.

## 2.10 RESILIENT PIPE GUIDES

### A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum 1/2-inch- (13-mm-) Thick Neoprene:

1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

## 2.11 ELASTOMERIC HANGERS

### A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:

1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.

2. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel-to-steel contact.

## 2.12 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
  1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
  2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
  7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
  8. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

## 2.13 SNUBBERS

- A. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
  1. Post-installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with ACI 318-14 Ch. 17 for 2015 or 2018 IBC. Preset concrete inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
  2. Anchors in Masonry: Design in accordance with TMS 402.
  3. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
  4. Resilient Cushion: Maximum 1/4-inch (6-mm) air gap, and minimum 1/4 inch (6 mm) thick.

## 2.14 RESTRAINTS - RIGID TYPE

- A. Description: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

## 2.15 RESTRAINTS - CABLE TYPE

- A. Seismic-Restraint Cables: ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts

designed for seismic restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.

- B. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge type end fittings do not comply and are unacceptable.

## 2.16 RESTRAINT ACCESSORIES

- A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Non-metallic stiffeners are unacceptable.
- B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings.
- C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

## 2.17 POST-INSTALLED CONCRETE ANCHORS

- A. Mechanical Anchor Bolts:
  - 1. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.
- B. Adhesive Anchor Bolts:
  - 1. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.
- C. Provide post-installed concrete anchors that have been prequalified for use in seismic applications. Post-installed concrete anchors must comply with all requirements of ASCE/SEI 7-05, Ch. 13.
  - 1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
  - 2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.
- D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp (7.46 kW), which is not vibration isolated.

1. Undercut expansion anchors are permitted.

## 2.18 CONCRETE INSERTS

- A. Provide preset concrete inserts, which are seismically prequalified in accordance with ICC-ES AC408 testing.
- B. Comply with ANSI/MSS 58.

## 2.19 VIBRATION ISOLATION EQUIPMENT BASES

- A. Steel Rails: Factory-fabricated, welded, structural-steel rails.
  1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.
    - a. Include supports for suction and discharge elbows for pumps.
  2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Rails shall have shape to accommodate supported equipment.
  3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- B. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.
  1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
    - a. Include supports for suction and discharge elbows for pumps.
  2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
  3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- C. Concrete Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
  1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
    - a. Include supports for suction and discharge elbows for pumps.
  2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
  3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
  4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength is adequate to carry static and seismic load within specified loading limits.

### 3.3 INSTALLATION OF VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICES

- A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Device Schedules, where indicated on Drawings, or where the Specifications indicate they are to be installed on specific equipment and systems.
- B. Provide seismic-restraint devices for systems and equipment where indicated in Equipment Schedules or Seismic-Restraint Devices Schedules, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.
- C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- D. Installation of vibration isolators and seismic restraints must not cause any stresses, misalignment, or change of position of equipment or piping.
- E. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- F. Equipment Restraints:
  - 1. Install snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
  - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).

3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- G. Piping Restraints:
1. Comply with requirements in MSS SP-127.
  2. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
  3. Brace a change of direction longer than 12 feet (3.7 m).
- H. Install seismic-restraint cables so they do not bend across edges of adjacent equipment or building structure.
- I. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- J. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- K. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- L. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- M. Post-Installed Concrete Anchors:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify Project structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
  2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
  3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
  4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
  5. Set anchors to manufacturer's recommended torque, using a torque wrench.
  6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

### 3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Provide flexible connections in piping systems where they cross structural seismic joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 221116 "Domestic Water Piping" and Section 221119 "Domestic Water Piping Specialties" for piping flexible connections.

### 3.5 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT BASES

- A. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- B. Coordinate dimensions of steel equipment rails, bases, and concrete inertia bases, with requirements of isolated equipment specified in this and other Sections. Where dimensions of bases are indicated on Drawings, they may require adjustment to accommodate actual isolated equipment.

### 3.6 ADJUSTING

- A. Adjust isolators after system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

### 3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Tests and Inspections:
  - 1. Perform tests and inspections with the assistance of a factory-authorized service representative.
  - 2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
  - 3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
  - 4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  - 5. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
  - 6. Test to 90 percent of rated proof load of device.
  - 7. Measure isolator restraint clearance.
  - 8. Measure isolator deflection.
  - 9. Verify snubber minimum clearances.
  - 10. Test and adjust restrained-air-spring isolator controls and safeties.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Units will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 22 05 48



## SECTION 22 05 53

### IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Warning signs and labels.
  - 3. Warning tape.
  - 4. Pipe labels.
  - 5. Stencils.
  - 6. Valve tags.
  - 7. Warning tags.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve-numbering scheme.
- E. Valve Schedules: For each piping system. Include in operation and maintenance manuals.

#### PART 2 - PRODUCTS

##### 2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
  - 1. Material and Thickness: Brass, 0.032-inch (0.8-mm) minimum thickness, with predrilled or stamped holes for attachment hardware.
  - 2. Letter and Background Color: As indicated for specific application under Part 3.
  - 3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

4. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  5. Fasteners: Stainless steel rivets or self-tapping screws.
  6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, with predrilled holes for attachment hardware.
  2. Letter and Background Color: As indicated for specific application under Part 3.
  3. Maximum Temperature: Able to withstand temperatures of up to 160 deg F (71 deg C).
  4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
  5. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  6. Fasteners: Stainless steel rivets or self-tapping screws.
  7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

## 2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, with predrilled holes for attachment hardware.
- B. Letter and Background Color: As indicated for specific application under Part 3.
- C. Maximum Temperature: Able to withstand temperatures of up to 160 deg F (71 deg C).
- D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- E. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- F. Fasteners: Stainless steel rivets or self-tapping screws.
- G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- H. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.
- I. Label Content: Include caution and warning information plus emergency notification instructions.

## 2.3 WARNING TAPE

- A. Material: Vinyl.
- B. Minimum Thickness: 0.005 inch (0.12 mm).
- C. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.
- D. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.
- E. Maximum Temperature: 160 deg F (70 deg C).
- F. Minimum Width: 2 inches (50 mm).

## 2.4 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.
- B. Letter and Background Color: As indicated for specific application under Part 3.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:
  - 1. Pipe size.
  - 2. Flow-Direction Arrows: Include flow-direction arrows on distribution piping. Arrows may be either integral with label or applied separately.
  - 3. Lettering Size: Size letters in accordance with ASME A13.1 for piping.

## 2.5 STENCILS

- A. Stencils for Piping:
  - 1. Lettering Size: Size letters in accordance with ASME A13.1 for piping.
  - 2. Stencil Material: Aluminum, brass, or fiberboard.
  - 3. Stencil Paint: Exterior, gloss, alkyd enamel in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
  - 4. Identification Paint: Exterior, alkyd enamel in colors in accordance with ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
  - 5. Letter and Background Color: As indicated for specific application under Part 3.

## 2.6 VALVE TAGS

- A. Description: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
  - 1. Tag Material: Brass, 0.04-inch (1.0-mm) minimum thickness, with predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass wire.
- B. Letter and Background Color: As indicated for specific application under Part 3.
  - C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
    1. Include valve-tag schedule in operation and maintenance data.

## 2.7 WARNING TAGS

- A. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
  1. Size: 3 by 5-1/4 inches (75 by 133 mm) minimum.
  2. Fasteners: Brass grommet and wire.
  3. Nomenclature: Large-size primary caption, such as "DANGER," "CAUTION," or "DO NOT OPERATE."
  4. Letter and Background Color: As indicated for specific application under Part 3.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

### 3.2 INSTALLATION, GENERAL REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Locate identifying devices so that they are readily visible from the point of normal approach.

### 3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

- A. Permanently fasten labels on each item of plumbing equipment.
- B. Sign and Label Colors.
  1. White letters on an ANSI Z535.1 safety-green background.
- C. Locate equipment labels where accessible and visible.

- D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where arc-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.

### 3.4 INSTALLATION OF WARNING TAPE

- A. Warning Tape Color and Pattern: Yellow background with black diagonal stripes.
- B. Install warning tape on pipes and ducts, with cross-designated walkways providing less than 6 ft. (2 m) of clearance.
- C. Locate tape so as to be readily visible from the point of normal approach.

### 3.5 INSTALLATION OF PIPE LABELS

- A. Piping Color Coding: Painting of piping is specified in Section 099123 "Interior Painting."
- B. Install pipe labels showing service and flow direction with permanent adhesive on pipes.
- C. Stenciled Pipe Label Option: Stenciled labels showing service and flow direction may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.
  - 1. Identification Paint: Use for contrasting background.
  - 2. Stencil Paint: Use for pipe marking.
- D. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  - 1. Within 3 ft. (1 m) of each valve and control device.
  - 2. At access doors, manholes, and similar access points that permit view of concealed piping.
  - 3. Within 3 ft. (1 m) of equipment items and other points of origination and termination.
  - 4. Spaced at maximum intervals of 25 ft. (8 m) along each run. Reduce intervals to 10 ft. (3 m) in areas of congested piping and equipment.
- E. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F (52 deg C) or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.
- F. Flow-Direction Flow Arrows: Use arrows, in compliance with ASME A13.1, to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- G. Pipe-Label Color Schedule:
  - 1. Low-Pressure Compressed-Air Piping: White letters on an ANSI Z535.1 safety-blue background.
  - 2. Domestic Cold-Water Piping: White letters on an ANSI Z535.1 safety-green background.
  - 3. Domestic Hot-Water Piping: White letters on an ANSI Z535.1 safety-green background.
  - 4. Domestic Hot-Water Return Piping: White letters on an ANSI Z535.1 safety-green background.

5. Sanitary Waste Piping: White letters on a black background.

### 3.6 INSTALLATION OF VALVE TAGS

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:
  1. Valve-Tag Size and Shape:
    - a. Domestic Cold Water: 1-1/2 inches (38 mm), round.
    - b. Domestic Hot Water: 1-1/2 inches (38 mm), round.
    - c. Domestic Hot-Water Return: 1-1/2 inches (38 mm), round.
    - d. Low-Pressure Compressed Air: 1-1/2 inches (38 mm), round.
  2. Valve-Tag Colors:
    - a. For each piping system, use the same lettering and background coloring system on valve tags as used in the piping system labels and background.

### 3.7 INSTALLATION OF WARNING TAGS

- A. Warning Tag Color: Black letters on an ANSI Z535.1 safety-yellow background.
- B. Attach warning tags, with proper message, to equipment and other items where indicated on Drawings.

END OF SECTION 22 05 53

## SECTION 22 05 93

### TESTING, ADJUSTING, AND BALANCING FOR PLUMBING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section Includes:
  - 1. TAB of domestic water system.
  - 2. TAB of plumbing equipment:
    - a. Domestic water booster pumps.
    - b. Domestic hot-water in-line circulation pumps.
    - c. Sanitary sewage pumps.
    - d. Drainage pumps.
  - 3. Pipe-leakage test verification.

##### 1.4 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- F. TDH: Total dynamic head.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.
- C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.
- D. System Readiness Checklists: Within 60 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB reports.
- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
  - 1. Instrument type and make.
  - 2. Serial number.
  - 3. Application.
  - 4. Dates of use.
  - 5. Dates of calibration.

## 1.6 QUALITY ASSURANCE

- A. TAB Specialists Qualifications, Certified by AABC:
  - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
  - 2. TAB Technician: Employee of the TAB specialist and certified by AABC.
- B. TAB Specialists Qualifications, Certified by NEBB or TABB:
  - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
  - 2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB.
- C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- D. ASHRAE 111 Compliance: Requirements in ASHRAE 111 applicable to analogous domestic water system and plumbing equipment balancing.
- E. ASHRAE 188 Compliance: Comply with balancing and report requirements, Section 8.3 "Balancing."
- F. Code and Authorities Having Jurisdiction Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.



## PART 2 - PRODUCTS (Not Applicable)

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves and fittings. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine approved submittals for plumbing systems and equipment.
- D. Examine design data, including plumbing system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about plumbing system and equipment controls.
- E. Examine equipment performance data, including pump curves.
  - 1. Relate performance data to Project conditions and requirements, including pump system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
  - 2. Calculate pump system-effect factors to reduce performance ratings of plumbing equipment when installed under conditions different from the conditions used to rate equipment performance. Compare results with the design data and installed conditions.
- F. Examine system and equipment installations, and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine plumbing equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- I. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainers are installed and clean.
- J. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.
- K. Examine system pumps to ensure absence of entrained air in the suction piping.
- L. Examine operating safety interlocks and controls on plumbing equipment.
- M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

### 3.2 PREPARATION

- A. Prepare a TAB plan that includes the following:
  - 1. Equipment and systems to be tested.
  - 2. Strategies and step-by-step procedures for balancing the systems.
  - 3. Instrumentation to be used.
  - 4. Sample forms with specific identification for all equipment.
  
- B. Perform system-readiness checks of plumbing systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
  - 1. Domestic Water System:
    - a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed in accordance with applicable code and authority having jurisdiction.
    - b. Water heaters are installed and functioning.
    - c. Piping is complete and all points of outlet are installed.
    - d. Water treatment is complete.
    - e. Systems are flushed, filled, and air purged.
    - f. Strainers are clean.
    - g. Control valves are functioning in accordance with the sequence of operation.
    - h. Shutoff and balance valves are 100 percent open.
    - i. Boost and hot-water circulating pumps are operational and proper rotation is verified.
    - j. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
    - k. Variable-frequency controllers' startup is complete and safeties are verified.
    - l. Suitable access to balancing devices and equipment is provided.
  
  - 2. Sanitary Sewage/Drainage System:
    - a. Leakage and pressure tests on sanitary sewage/drainage systems have been completed in accordance with applicable code and authority having jurisdiction requirements.
    - b. Piping is complete.
    - c. Sanitary sewage pumps/drainage pumps are operational.
    - d. Control valves are functioning in accordance with the sequence of operation.
    - e. Shutoff valves are 100 percent open.
    - f. Suitable access to equipment is provided.

### 3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.
  
- B. Cut insulation, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
  - 1. Where holes for probes are required in piping or equipment, install pressure and temperature test plugs to seal systems.

2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 220716 "Plumbing Equipment Insulation" and Section 220719 "Plumbing Piping Insulation."
- C. Mark equipment and balancing devices, including valve position indicators and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

### 3.4 GENERAL PROCEDURES FOR PLUMBING EQUIPMENT

- A. Test, adjust, and balance plumbing equipment indicated on Drawings, including, but not limited to, the following:
  1. Motors.
  2. Domestic water booster pumps.
  3. Domestic water in-line pumps.
  4. Domestic water heaters.
  5. Sanitary sewage pumps.
  6. Drainage pumps.

### 3.5 PROCEDURES FOR DOMESTIC WATER SYSTEMS

- A. Prepare test reports for pumps and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.
- B. Prepare schematic diagrams of systems' Record drawings piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare domestic water systems for testing and balancing as follows:
  1. Check expansion tank for proper setting.
  2. Check water heater for proper discharge temperature setting.
  3. Check remotest point of outlet for adequate pressure.
  4. Check flow-control valves for proper position.
  5. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
  6. Verify that motor controllers are equipped with properly sized thermal protection.
  7. Check that air has been purged from the system.
- D. Measure and record upstream and downstream pressure of each piece of equipment.
- E. Measure and record upstream and downstream pressure of pressure-reducing valves.
- F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
- G. Check settings and operation of each safety valve. Record settings.

### 3.6 PROCEDURES FOR DOMESTIC WATER SYSTEM BOOSTER PUMPS

- A. Adjust pumps to deliver total design flow.

1. Measure total water flow.
  - a. Position valves for full flow through coils.
  - b. Measure flow by main flow meter, if installed.
  - c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
2. Measure pump TDH as follows:
  - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
  - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
  - c. Convert pressure to head and correct for differences in gauge heights.
  - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
  - e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.
3. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.

B. Adjust flow-measuring devices installed in mains and branches to design water flows.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

C. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
3. Mark final settings.

D. Verify that memory stops have been set.

### 3.7 PROCEDURES FOR DOMESTIC HOT-WATER CIRCULATING INLINE PUMP

A. Balance system with manual or automatic balancing valves by setting at design flow.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

B. Adjust pump to deliver total design flow.

1. Measure pump TDH as follows:
  - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
  - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.

- c. Convert pressure to head and correct for differences in gauge heights.
  - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
2. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
  3. Mark final settings and verify that all memory stops have been set.
  4. Verify final system conditions as follows:
    - a. Re-measure and confirm that total flow is within design.
    - b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
    - c. Mark final settings.

### 3.8 PROCEDURES FOR MOTORS

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
  1. Manufacturer's name, model number, and serial number.
  2. Motor horsepower rating.
  3. Motor rpm.
  4. Phase and hertz.
  5. Nameplate and measured voltage, each phase.
  6. Nameplate and measured amperage, each phase.
  7. Starter size and thermal-protection-element rating.
  8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

### 3.9 PROCEDURES FOR WATER HEATERS

- A. Gas- and Oil-Fired Water Heaters:
  1. Measure and record entering- and leaving-water temperatures.
  2. Measure and record water flow.
  3. Measure and record pressure drop.
  4. Measure and Record relief valve(s) pressure setting.
  5. Capacity: Calculate in Btu/h (kW) of heating output.
  6. Fuel Consumption: If fuel supply is equipped with flow meter, measure and record consumption.
  7. Efficiency: Calculate operating efficiency for comparison to submitted equipment.
  8. Fan, motor, and motor controller operating data.

### 3.10 TOLERANCES

- A. Set plumbing system's flow rates within the following tolerances:
  1. Domestic Water Flow Rate: Plus or minus 10 percent. If design value is less than 10 gpm (0.63 L/s), within 10 percent.

### 3.11 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to plumbing systems and general construction to allow access for performance-measuring and -balancing devices.
- B. Status Reports: Prepare monthly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

### 3.12 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
  - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
  - 2. Include a list of instruments used for procedures, along with proof of calibration.
  - 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
  - 1. Pump curves.
  - 2. Manufacturers' test data.
  - 3. Field test reports prepared by system and equipment installers.
  - 4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
  - 1. Title page.
  - 2. Name and address of the TAB specialist.
  - 3. Project name.
  - 4. Project location.
  - 5. Architect's name and address.
  - 6. Engineer's name and address.
  - 7. Contractor's name and address.
  - 8. Report date.
  - 9. Signature of TAB supervisor who certifies the report.
  - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
  - 11. Summary of contents, including the following:
    - a. Indicated versus final performance.
    - b. Notable characteristics of systems.
    - c. Description of system operation sequence if it varies from the Contract Documents.
  - 12. Nomenclature sheets for each item of equipment.
  - 13. Notes to explain why certain final data in the body of reports vary from indicated values.

14. Test conditions for pump performance forms, including the following:
  - a. Variable-frequency controller settings for variable-flow hydronic systems.
  - b. Settings for pressure controller(s).
  - c. Other system operating conditions that affect performance.
  
- D. System Diagrams: Include schematic layouts of distribution systems. Present each system with single-line diagram and include the following:
  1. Flow rates.
  2. Pipe and valve sizes and locations.
  3. Balancing stations.
  4. Position of balancing devices.
  
- E. Gas-Fired Water Heaters Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
  1. Unit Data:
    - a. System identification.
    - b. Location.
    - c. Make and type.
    - d. Model number and unit size.
    - e. Manufacturer's serial number.
    - f. Fuel type in input data.
    - g. Output capacity in Btu/h (kW).
    - h. Ignition type.
    - i. Burner-control types.
    - j. Motor horsepower and speed.
    - k. Motor volts, phase, and hertz.
    - l. Motor full-load amperage and service factor.
    - m. Sheave make, size in inches (mm), and bore.
    - n. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
  
  2. Test Data (Indicated and Actual Values):
    - a. Total airflow rate in cfm (L/s).
    - b. Entering-water temperature in deg F (deg C).
    - c. Leaving-water temperature in deg F (deg C).
    - d. Low-fire fuel input in Btu/h (kW).
    - e. High-fire fuel input in Btu/h (kW).
    - f. High-temperature-limit setting in deg F (deg C).
    - g. Operating set point in Btu/h (kW).
    - h. Heating value of fuel in Btu/h (kW).
  
- F. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:
  1. Unit Data:
    - a. Unit identification.
    - b. Location.
    - c. Service.
    - d. Make and size.
    - e. Model number and serial number.

- f. Water flow rate in gpm (L/s).
- g. Water-pressure differential in feet of head or psig (kPa).
- h. Required net positive suction head in feet of head or psig (kPa).
- i. Pump speed.
- j. Impeller diameter in inches (mm).
- k. Motor make and frame size.
- l. Motor horsepower and rpm.
- m. Voltage at each connection.
- n. Amperage for each phase.
- o. Full-load amperage and service factor.
- p. Seal type.

2. Test Data (Indicated and Actual Values):

- a. Static head in feet of head or psig (kPa).
- b. Pump shutoff pressure in feet of head or psig (kPa).
- c. Actual impeller size in inches (mm).
- d. Full-open flow rate in gpm (L/s).
- e. Full-open pressure in feet of head or psig (kPa).
- f. Final discharge pressure in feet of head or psig (kPa).
- g. Final suction pressure in feet of head or psig (kPa).
- h. Final total pressure in feet of head or psig (kPa).
- i. Final water flow rate in gpm (L/s).
- j. Voltage at each connection.
- k. Amperage for each phase.

G. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

3.13 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Commissioning Authority.
- B. Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
- C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.



- E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:
  - 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
  - 2. If the second final inspection also fails, Owner may pursue other Contract options to complete TAB work.
- F. Prepare test and inspection reports.

### 3.14 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

END OF SECTION 22 05 93

## SECTION 22 07 19

### PLUMBING PIPING INSULATION

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section includes insulating the following plumbing piping services:
  - 1. Domestic cold-water piping.
  - 2. Domestic hot-water piping.
  - 3. Domestic recirculating hot-water piping.
  - 4. Domestic chilled-water piping for drinking fountains.
  - 5. Sanitary waste piping exposed to freezing conditions.
  - 6. Storm-water piping exposed to freezing conditions.
  - 7. Roof drains and rainwater leaders.
  - 8. Supplies and drains for handicap-accessible lavatories and sinks.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
- B. Sustainable Design Submittals:
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
  - 2. Detail attachment and covering of heat tracing inside insulation.
  - 3. Detail insulation application at pipe expansion joints for each type of insulation.
  - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
  - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
  - 6. Detail application of field-applied jackets.
  - 7. Detail application at linkages of control devices.
- D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
  - 1. Preformed Pipe Insulation Materials: 12 inches (300 mm) long by NPS 2 (DN 50).
  - 2. Jacket Materials for Pipe: 12 inches (300 mm) long by NPS 2 (DN 50).

3. Sheet Jacket Materials: 12 inches (300 mm) square.
4. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Comply with the following applicable standards and other requirements specified for miscellaneous components:
  1. Supply and Drain Protective Shielding Guards: ICC A117.1.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include name of the manufacturer, fabricator, type, description, and size, as well as ASTM standard designation and maximum use temperature.

#### 1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

#### 1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
  - 1. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

### 2.2 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials are applied.
- B. Products do not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come into contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.
- D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.
- E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric: Closed-cell or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg F (minus 57 deg C) and 220 deg F (104 deg C). Comply with ASTM C534/C534M, Type I for tubular materials.
- G. Mineral Wool, Preformed Pipe: Mandrel-wound mineral wool fibers bonded with a thermosetting resin, unfaced; suitable for maximum use temperature up to 1200 deg F (650 deg C) in accordance with ASTM C447. Comply with ASTM C547.
  - 1. Preformed Pipe Insulation: Type II, Grade A with factory-applied ASJ.
  - 2. Fabricated shapes in accordance with ASTM C450 and ASTM C585.

### 2.3 INSULATING CEMENTS

- A. Glass-Fiber and Mineral Wool Insulating Cement: Comply with ASTM C195.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.
- C. Glass-Fiber and Mineral Wool Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

### 2.4 ADHESIVES

- A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

- B. Flexible Elastomeric Adhesive: Solvent-based adhesive.
  - 1. Flame-spread index is 25 or less and smoke-developed index is 50 or less as tested in accordance with ASTM E84.
  - 2. Wet Flash Point: Below 0 deg F (minus 18 deg C).
  - 3. Service Temperature Range: 40 to 200 deg F (4 to plus 93 deg C).
  - 4. Color: Black.
- C. Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- D. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.

## 2.5 MASTICS AND COATINGS

- A. Materials are compatible with insulation materials, jackets, and substrates.
- B. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.
  - 1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
  - 2. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
  - 3. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
  - 4. Color: White.
- C. Vapor-Retarder Mastic, Solvent Based, Indoor Use: Suitable for indoor use on below-ambient services.
  - 1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
  - 2. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).
  - 3. Color: White.
- D. Vapor-Retarder Mastic, Solvent Based, Outdoor Use: Suitable for outdoor use on below-ambient services.
  - 1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
  - 2. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).
  - 3. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
  - 1. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm (0.66 metric perms) at manufacturer's recommended dry film thickness.
  - 2. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
  - 3. Color: White.

## 2.6 LAGGING ADHESIVES

- A. Adhesives comply with MIL-A-3316C, Class I, Grade A, and are compatible with insulation materials, jackets, and substrates.
  - 1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
  - 2. Service Temperature Range: 20 to plus 180 deg F (Minus 6 to plus 82 deg C).
  - 3. Color: White.

## 2.7 SEALANTS

- A. Materials are as recommended by the insulation manufacturer and are compatible with insulation materials, jackets, and substrates.
- B. Joint Sealants:
  - 1. Permanently flexible, elastomeric sealant.
  - 2. Service Temperature Range: Minus 58 to plus 176 deg F (Minus 50 to plus 80 deg C).
  - 3. Color: White or gray.
- C. FSK and Metal Jacket Flashing Sealants:
  - 1. Fire- and water-resistant, flexible, elastomeric sealant.
  - 2. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
  - 3. Color: Aluminum.
- D. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:
  - 1. Fire- and water-resistant, flexible, elastomeric sealant.
  - 2. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
  - 3. Color: White.

## 2.8 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
  - 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
  - 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
  - 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
  - 4. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136 Types I, II, III, IV, and VII.
  - 5. PSK Jacket: Aluminum foil fiberglass reinforced scrim with polyethylene backing, complying with ASTM C1136, Type II.

## 2.9 FIELD-APPLIED JACKETS

- A. Field-applied jackets comply with ASTM C1136, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
  - 1. Adhesive: As recommended by jacket material manufacturer.
  - 2. Color: White.
  - 3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
    - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Metal Jacket:

1. Aluminum Jacket: Comply with ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.

- a. Sheet and roll stock ready for shop or field sizing.
- b. Finish and thickness are indicated in field-applied jacket schedules.
- c. Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper.
- d. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
- e. Factory-Fabricated Fitting Covers:
  - 1) Same material, finish, and thickness as jacket.
  - 2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
  - 3) Tee covers.
  - 4) Flange and union covers.
  - 5) End caps.
  - 6) Beveled collars.
  - 7) Valve covers.
  - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2. Stainless Steel Jacket: ASTM A240/A240M.

- a. Sheet and roll stock ready for shop or field sizing.
- b. Material, finish, and thickness are indicated in field-applied jacket schedules.
- c. Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper.
- d. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
- e. Factory-Fabricated Fitting Covers:
  - 1) Same material, finish, and thickness as jacket.
  - 2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
  - 3) Tee covers.
  - 4) Flange and union covers.
  - 5) End caps.
  - 6) Beveled collars.
  - 7) Valve covers.
  - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Underground Direct-Buried Jacket: 125-mil- (3.2-mm-) thick vapor barrier and waterproofing membrane, consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

F. Self-Adhesive Outdoor Jacket (Asphaltic): 60-mil- (1.5-mm-) thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with white aluminum-foil facing.

G. Self-Adhesive Indoor/Outdoor Jacket (Non-Asphaltic): Vapor barrier and waterproofing jacket for installation over insulation located aboveground outdoors or indoors. Specialized jacket with five layers of laminated aluminum and polyester film with low-temperature acrylic pressure-

sensitive adhesive. Outer aluminum surface is coated with UV-resistant coating for protection from environmental contaminants.

1. Permeance: 0.00 perm as tested in accordance with ASTM F1249.
2. Flamespread/Smoke Developed: 25/50 as tested in accordance with ASTM E84.
3. Aluminum Finish: Embossed.

## 2.10 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
1. Width: 3 inches (75 mm).
  2. Thickness: 11.5 mils (0.29 mm).
  3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
  4. Elongation: 2 percent.
  5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
  6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
1. Width: 3 inches (75 mm).
  2. Thickness: 6.5 mils (0.16 mm).
  3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
  4. Elongation: 2 percent.
  5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
  6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Width: 2 inches (50 mm).
  2. Thickness: 6 mils (0.15 mm).
  3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
  4. Elongation: 500 percent.
  5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches (50 mm).
  2. Thickness: 3.7 mils (0.093 mm).
  3. Adhesion: 100 ounces force/inch (1.1 N/mm)] in width.
  4. Elongation: 5 percent.
  5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

## 2.11 SECUREMENTS

- A. Bands:
1. Stainless Steel: ASTM A240/A240M; 0.015 inch (0.38 mm) thick, wide with wing seal.
  2. Aluminum: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, wide with wing seal.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.
- C. Wire: 0.080-inch (2.0-mm) nickel-copper alloy.



## 2.12 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers:
  - 1. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
- B. Protective Shielding Piping Enclosures:
  - 1. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  - 1. Verify that systems to be insulated have been tested and are free of defects.
  - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
  - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range of between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
  - 2. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

### 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.
- D. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
  - 3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
  - 2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches (100 mm) o.c.
    - a. For below-ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

- M. Cut insulation in a manner to avoid compressing insulation.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.
- P. For above-ambient services, do not install insulation to the following:
  - 1. Vibration-control devices.
  - 2. Testing agency labels and stamps.
  - 3. Nameplates and data plates.
  - 4. Cleanouts.

### 3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
  - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
  - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
  - 1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles below.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation made from same material and density as that of adjacent pipe insulation. Each piece is butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

- D. Install removable insulation covers at locations indicated. Installation conforms to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
  2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
  3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
  4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
  5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### 3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
  2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
  4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.
  2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install prefabricated valve covers manufactured of same material as that of pipe insulation when available.
  2. When prefabricated valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.7 INSTALLATION OF MINERAL WOOL INSULATION

#### A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches (150 mm) o.c.
4. For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

#### B. Insulation Installation on Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with glass-fiber or mineral-wool blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

#### C. Insulation Installation on Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

#### D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated sections are not available, install fabricated sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

### 3.8 INSTALLATION OF FIELD-APPLIED JACKETS

#### A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.

3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
  2. Install lap or joint strips with same material as jacket.
  3. Secure jacket to insulation with manufacturer's recommended adhesive.
  4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
  5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches (300 mm) o.c. and at end joints.

### 3.9 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless steel jackets.

### 3.10 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing agency to perform tests and inspections.
- B. Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.

- E. All insulation applications will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

### 3.11 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
  - 1. Drainage piping located in crawl spaces.
  - 2. Underground piping.
  - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

### 3.12 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
  - 1. NPS 1 (DN 25) and Smaller: Insulation is one of the following:
    - a. Flexible Elastomeric: 1 inch (25 mm) thick.
    - b. Mineral Wool, Preformed Pipe Insulation, Type II: 1 inch (25 mm) thick.
  - 2. NPS 1-1/4 (DN 32) and Larger: Insulation is one of the following:
    - a. Flexible Elastomeric: 1 inch (25 mm) thick.
    - b. Mineral Wool, Preformed Pipe Insulation, Type II: 1 inch (25 mm)] thick.
- B. Domestic Hot and Recirculated Hot Water:
  - 1. NPS 1-1/4 (DN 32) and Smaller: Insulation is one of the following:
    - a. Flexible Elastomeric: 1 inch (25 mm) thick.
    - b. Mineral Wool, Preformed Pipe Insulation, Type II: 1 inch (25 mm) thick.
  - 2. NPS 1-1/2 (DN 40) and Larger: Insulation is one of the following:
    - a. Flexible Elastomeric: 1 inch (25 mm) thick.
    - b. Mineral Wool, Preformed Pipe Insulation, Type II: 1 inch (25 mm) thick.
- C. Domestic Chilled Water (Potable):
  - 1. All Pipe Sizes: Insulation is one of the following:
    - a. Flexible Elastomeric: 1 inch (25 mm) thick.
    - b. Mineral Wool, Preformed Pipe Insulation, Type II: 1 inch (25 mm) thick.
- D. Stormwater and Overflow:
  - 1. All Pipe Sizes: Insulation is one of the following:
    - a. Flexible Elastomeric: 1 inch (25 mm) thick.
    - b. Mineral Wool, Preformed Pipe Insulation, Type II: 1 inch (25 mm) thick.
- E. Roof Drain and Overflow Drain Bodies:
  - 1. All Pipe Sizes: Insulation is one of the following:



- a. Flexible Elastomeric: 1 inch (25 mm) thick.
  - b. Mineral Wool, Preformed Pipe Insulation, Type II: 1 inch (25 mm) thick.
- F. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
  - 1. All Pipe Sizes: Insulation is one of the following:
    - a. Flexible Elastomeric: 3/4 inch (19 mm) thick.
    - b. Mineral Wool, Preformed Pipe Insulation, Type II: 1 inch (25 mm) thick.
- G. Sanitary Waste Piping Where Heat Tracing Is Installed:
  - 1. All Pipe Sizes: Insulation is one of the following:
    - a. Mineral Wool, Preformed Pipe Insulation, Type II: 1-1/2 inches (38 mm) thick.
- H. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet (3 m) of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):
  - 1. All Pipe Sizes: Insulation is one of the following:
    - a. Flexible Elastomeric: 3/4 inch (19 mm) thick.
    - b. Mineral Wool, Preformed Pipe Insulation, Type II: 1 inch (25 mm) thick.
- I. Hot Service Drains:
  - 1. All Pipe Sizes: Insulation is one of the following:
    - a. Mineral Wool, Preformed Pipe Insulation, Type II: 1 inch (25 mm) thick.
- J. Hot Service Vents:
  - 1. All Pipe Sizes: Insulation is one of the following:
    - a. Mineral Wool, Preformed Pipe Insulation, Type II: 1 inch (25 mm) thick.

### 3.13 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Domestic Water Piping:
  - 1. All Pipe Sizes: Insulation is one of the following:
    - a. Flexible Elastomeric: 2 inches (50 mm) thick.
    - b. Mineral Wool, Preformed Pipe Insulation, Type II: 2 inches (50 mm) thick.
- B. Sanitary Waste Piping Where Heat Tracing Is Installed:
  - 1. All Pipe Sizes: Insulation is one of the following:
    - a. Mineral Wool, Preformed Pipe Insulation, Type II: 2 inches (50 mm) thick.

### 3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.

D. Piping, Exposed:

1. None.

2. PVC: 20 mils (0.5 mm) thick.

### 3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.

2. PVC: 30 mils (0.8 mm) thick.

D. Piping, Exposed:

1. PVC: 40 mils (1.0 mm) thick.

### 3.16 UNDERGROUND, FIELD-APPLIED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 22 07 19

**SECTION 220800  
COMMISSIONING OF PLUMBING**

**PART 1 - GENERAL**

**1.1 STIPULATIONS**

- A. The specifications sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

**1.2 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

**1.3 DESCRIPTION**

- A. General provisions and other plumbing systems are specified in other Sections of Division 22.
- B. Commissioning is an ongoing process and shall be performed throughout construction. Commissioning requires the participation of Division 22 to ensure that all systems are operating in a manner consistent with the Contract Documents. Division 22 shall be familiar with the commissioning plan issued by the CA as it applies to the work of Division 22 and shall execute all commissioning responsibilities assigned to them in the Contract Documents. The contractors should also review Specifications Section 019113 for additional information.
- C. Commissioning shall conclude with the completion of all required deferred testing, training and system documentation as specified and required to ensure the proper operation of the plumbing equipment and systems provided by this Division.
- D. This Section covers Plumbing systems commissioning, as required to demonstrate that the equipment and systems of Division 22 are ready for safe and satisfactory operation, as defined by project documents. Commissioning shall include, but shall not be limited to, identification of piping and equipment, cleaning, lubrication, start-up, check-out, and testing, adjusting, and balancing of systems, preparation of equipment and systems documentation and of maintenance and operation manuals, Owner training, and preparation of record drawings.
- E. This section does not alter the commissioning requirements indicated in Section 220000 of the building specifications. This section is to help define/supplement the requirements of Section 220000 where applicable.

**1.4 QUALITY ASSURANCE**

- A. The Plumbing contractor shall identify a Plumbing commissioning supervisor. The Plumbing commissioning supervisor shall have a minimum of ten years experience in Plumbing contracting. The Plumbing commissioning supervisor shall become familiar with the design intent and the requirements of the commissioning process as defined in this Section. The Plumbing commissioning supervisor shall attend all commissioning meetings and coordinate the commissioning schedule as outline by the commissioning agent. The Plumbing commissioning supervisor shall assist the CA in coordinating and executing the required commissioning activities.

## 1.5 PLUMBING CONTRACTOR RESPONSIBILITIES

- A. The Plumbing commissioning supervisor shall be responsible for scheduling, supervising, and coordinating the startup, testing, and commissioning activities as specified herein with the CA. Specific requirements of the Plumbing contractor and associated subcontractors are identified in this Section and in other Sections of this Division.
- B. The CA shall conduct independent verification of installation, pre-functional, start-up and functional testing as per section 019113.
- C. Plumbing commissioning shall take place in three phases. Commissioning requirements for each phase are as follows:
  - 1. Construction Phase
    - a. Contractor shall attend a Commissioning Scoping meeting and additional commissioning meetings as required throughout the commissioning process. These commissioning meetings will be monthly during early construction and may increase in frequency to weekly during the start-up, prefunctional and functional testing phases. Contractor shall assure that all subcontractors who have commissioning responsibilities attend the Commissioning Scoping meeting and other commissioning meetings, as appropriate, during the construction process.
    - b. Contractor shall report in writing to the CA at least as often as commissioning meetings are scheduled concerning the status of his activities as they affect the commissioning process, the status of each discrepancy identified, the prefunctional and functional testing process, explanations of any disagreements with the identified deficiencies, and proposed resolution and schedule.
    - c. Contractor shall provide the CA with normal cut sheets and shop drawing submittals of equipment that is to be commissioned.
    - d. Contractor shall provide documentation to the CA for development of pre-functional and functional performance testing procedures, prior to normal O&M manual submittals. This documentation shall include detailed manufacturer installation, start-up, operating, troubleshooting and maintenance procedures; full details of any owner-contracted tests; fan and pump curves; full factory testing reports, if any; and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation, start-up, and checkout materials that are shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Agent. The Commissioning Agent may request further documentation necessary for the development of functional performance testing and the commissioning process. This data request may be made prior to normal submittals.
    - e. Contractor shall develop and submit to CA, for review prior to equipment or system startup, a complete startup and initial checkout plan using manufacturer's start-up procedures. The commissioning agent shall conduct their own pre-functional testing check in parallel with the contractors.
    - f. Contractor shall review the commissioning agent's pre-functional check sheets and sign-off on the appropriate areas when contractor and sub-

contractors are complete. The prefunctional test sheets will be developed by the commissioning agent. Only when each portion of the pre-functional test sheet is signed off will the contractor be able to move onto the next phase of the start-up and check-out. Detailed in Specification Section 019113, 2.1 "Overview Sign-Off Sheet"

- g. Contractor shall provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, to the CA for review.
- h. Contractor shall assist in clarifying the proposed operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
- i. CA shall prepare the specific functional test procedures as specified herein. The contractors shall review the CA's proposed functional performance test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
- j. Commissioning agent shall prepare a preliminary schedule for Division 22 commissioning activities, to include pipe and duct system testing, flushing, and cleaning, equipment start-up, and TAB start and completion, for use by the CA and shall update the schedule as appropriate. The contractor shall update the commissioning activities and notify any delays in the progress meetings. Contractor shall notify the CA during the commissioning meetings when commissioning activities not yet performed or not yet scheduled will delay construction.
- k. Plumbing equipment start-up shall not be initiated until the complete sign-off of the pre-functional check-sheets as developed by the commissioning agent as specified in other Sections of Division 22.
- l. Contractor shall provide startup testing for all plumbing equipment and shall execute the portions of the prefunctional checklists for all commissioned equipment during the startup and initial checkout process. The commissioning agent shall conduct an independent check out once the contractor is complete with their requirements.
- m. Contractor shall perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CA.
- n. Contractor shall correct current A/E punch list and CA deficiency items before functional performance testing can begin. Domestic water TAB shall be completed with discrepancies and problems remedied before functional testing of the respective water related systems.
- o. The commissioning agent shall generate the functional testing procedure and provide record to the Plumbing contractor. The Plumbing contractor shall review and provide support for the functional testing process. Contractor shall operate systems in accordance with the CA requirements as directed by the commissioning agent and the functional testing procedures.
- p. Contractor shall report in writing to the CA at least as often as commissioning meetings are being scheduled concerning the status of each outstanding discrepancy identified during commissioning, prefunctional and functional performance testing. Report shall include description of the identified discrepancy, explanations of any disagreements, and proposals and schedule for correction of the discrepancy.

- 2. Acceptance Phase. Contractor shall assist and cooperate with the CA in the commissioning process by:

- a. Putting all plumbing equipment and systems into operation and continuing the operation during each working day of the test and balance and commissioning efforts, as required.
  - b. For a given area, have all required prefunctional checklists, calibrations, startup and selected functional tests of the plumbing system and associated controls completed and approved by the CA prior to beginning the test and balance process.
  - c. Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.
  - d. Installing a P/T plug at each water sensor that is an input point to the Control System.
  - e. Providing skilled technicians to execute starting and operation of equipment.
  - f. The commissioning agent will conduct functional performance testing. The contractor may be required to have a skilled technician present during functional testing although it is suggested that one be available to make adjustments or assist in problem-solving.
  - g. The commissioning will require full and part load performance verifications as well as seasonal and simulated testing requirements. The contractor shall be prepared to operate different components of various systems (example, chilled water and hot water systems to generate loading strategies) during the functional testing.
  - h. Correct deficiencies (differences between specified and observed performance) as interpreted by the CA and A/E.
  - i. Prepare O&M manuals according to the Contractor Documents, including clarifying and updating the original sequence of operation to as-built conditions.
  - j. Maintain on site redline as built drawings and produce final "As-built" drawings for all project drawings and contractor-generated coordination drawings. List and clearly identify on the as-built drawings the locations of all airflow stations and sensor installations that are not equipment mounted.
  - k. Provide specified training of the Owner's operating personnel in accordance with the commissioning agent's overview and outline.
  - l. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
  - m. Provide updated diagrammatical logic for all TAB adjustments to the system.
3. Warranty Period. During the warranty period, the contractor shall:
- a. Be available during seasonal or deferred functional performance testing conducted by the CA, according to the specifications.
  - b. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

## PART 2 - PRODUCTS

### 2.1 SYSTEMS TO BE COMMISSIONED

A. The following are systems to be commissioned.

- 1. Domestic Hot Water

## 2.2 TEST EQUIPMENT

- A. All standard testing equipment required to the Plumbing portion startup, initial checkout shall be provided by the contractor responsible for the equipment or system being tested.
- B. The commissioning agent shall perform their own system verification and performance check-out. The commissioning agent shall provide their own calibrated equipment as required for this testing.
- C. All testing equipment associated with functional performance verification and point-to-point required by the commissioning agent shall be the responsibility of the commissioning agent.
- D. Special equipment, tools, and instruments (only available from vendor or specific to a piece of equipment) required for the functional testing of that equipment, according to the requirements of the contract documents and the functional test procedures shall be provided to the CA by the installing contractor and shall become the property of the Owner at project completion as indicated in the specification.
- E. Proprietary test equipment and software required by any manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon successful completion of the commissioning process as required in the specifications.

## PART 3 - EXECUTION

### 3.1 SUBMITTALS

- A. Division 22 shall provide submittal documentation relative to commissioning as required in this Section Part 1 and Section 019113.

### 3.2 STARTUP PLAN AND PREFUNCTIONAL TESTING

- A. The Plumbing contractor and associated subcontractors shall be responsible for the installation of complete systems and sub-systems, fully functional, meeting the design objectives of the Contract Documents. Contractor shall follow the approved start-up, initial checkout, and prefunctional testing procedures. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility to the commissioning agent or Owner.
- B. Prefunctional testing as directed and performed by the commissioning agent shall be required for each piece of equipment to ensure that the equipment and systems are properly installed and ready for operation, so that functional performance testing may proceed without delays. Sampling strategies shall not be used for prefunctional testing. The prefunctional testing for all equipment and subsystems of a given system shall be successfully completed and documented prior to functional performance testing of the system. The Plumbing contractor and sub-contractors shall sign off on the CA's prefunctional test sheets that they are complete, and the system is ready. The commissioning agent will verify and conduct their own independent verification and start-up in parallel to the contractor's verification. Any deficiencies identified during this process shall be noted and reviewed by the contractors. Start-up and functional testing shall not proceed until all the deficiencies are corrected and verified by the commissioning agent.
- C. The following procedures shall apply to all equipment and systems to be commissioned.

1. Start-up and Initial Checkout Plan. The Commissioning Agent shall develop the detailed start-up and prefunctional testing plans for all equipment. The primary role of the CA in this process shall be to review the installation for construction completeness and ensure that all components have been installed as per the design documents. Only when pre-functional testing is complete and signed off by all contractors, shall the equipment be started up by the contractor. Equipment and systems to be commissioned are identified in this Section Part 2.
  2. The start-up and initial checkout plan shall consist of the following as a minimum:
    - a. The manufacturer's standard written start-up and checkout procedures copied from the installation manuals and manufacturer's normally used field checkout sheets. The plan shall include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.
    - b. First-run checklist for equipment, to include:
      - 1) Equipment properly set.
      - 2) Adjustment of vibration isolators.
      - 3) Piping and equipment properly connected.
      - 4) Completion of initial lubrication procedures.
      - 5) Wiring properly connected.
      - 6) Electrical overload relays appropriate for load.
      - 7) Electrical accessories properly installed and adjusted.
      - 8) Controls, safeties, and time switches properly calibrated and set-up
  3. The Commissioning Agent shall determine which trade is responsible for executing and documenting each of the line-item tasks and note that trade on the form. Each form may have more than one trade responsible for its execution.
  4. The Contractor shall submit the startup reports to the CA for review.
- D. The CA shall review and approve the procedures and the format for documenting them, noting any procedures that need to be added.
- E. Two weeks prior or startup, the contractor shall schedule startup and checkout with the Owner and CA. The execution of the startup and checkout shall be directed and performed by the contractor, in accordance with manufacturer's published procedures and with the approved procedures. The CA shall be present for the contractor's required startup and checkout of all systems and equipment to be commissioned.
- F. Sensor Calibration. Calibration of all sensors shall be included as part of the prefunctional testing and listed on the appropriate test checklists and reports, according to the specified procedures and accuracies for the devices and systems being tested.
- G. All contractor responsible start-up, checkout forms shall be completed and submitted to the CA for review.

### 3.3 FUNCTIONAL PERFORMANCE TESTS

- A. Functional Performance Verification (FPV) is the dynamic testing of systems (rather than just individual components) under full, part, and seasonal requirements. Systems are tested under various loads and control sequences, such as low cooling and heating loads, component failures, unoccupied modes, fire alarm, etc. The systems are run through all the control sequences of operation and components are verified to be responding as the design intent and documents. Functional performance verification shall include testing all sequences of operations, verification of system capacity, generating simulated signals to simulate sensor values, conducting simulated conditions



to tests all loads and verify system performance during all conditions of operation and verifying design intent. In addition, each system shall be tested through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part and full load). Proper responses such as power failures, freeze conditions, low-oil pressures, equipment failures, etc. shall also be tested. The commissioning authority develops the functional test sheets and procedures in sequential written form, coordinates the testing, conducts the testing, and documents the testing. Each contractor is required is supply personnel to assist during the functional performance testing where applicable.

- B. No system, equipment or component thereof shall be tested until the contractor and the CM has certified, in writing, that the system, equipment and / or components are complete, have been tested, adjusted, and balanced and are ready for validating and performance testing. Functional Performance Verification is scheduled by the commissioning agent after the pre-functional testing requirements are complete and signed-off by the CM and the CA. Functional Performance Verification will not be conducted until a written notice of completion by the CM confirming that the system is ready for FPV. The air balancing and water balancing must be complete, and the controls must be debugged prior to the performance verification.
- C. Functional testing shall be conducted by the commissioning agent. Functional testing may not proceed until the systems have been properly installed, started-up and all deficiencies have been corrected.
- D. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CA and CM. Beginning system testing before full completion shall not relieve the Contractor from fully completing the system, including all prefunctional checklists.
- E. The contractor shall provide personnel to operate the systems while functional performance testing is commencing. This shall include but not be limited to; starting and stopping of systems, opening, and closing valves to create false loads on the system (with the capabilities of the existing system) and allowing the commissioning agent to manipulate the building automation systems to modulate the system requirements.
- F. The contractor shall review the commissioning functional performance testing procedure supplied by the commissioning agent. After functional testing commences, the contractor and the commissioning agent shall sign the functional test record and provide the owner and the CM a copy to review. All deficiencies either corrected in the field or outstanding shall be documented on the functional test forms for review by all parties.
- G. All Functional Testing must be completed and approved by the commissioning agent and the owner before the project will be considered substantially complete.

### 3.4 TESTING DOCUMENTATION, NON-CONFORMANCE, AND APPROVALS

- A. The commissioning agent shall clearly list any outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the testing form or on an attached sheet. The testing form and any outstanding deficiencies shall be provided to the CM / Owner within two days of test completion. The CA shall review the contractor's startup testing reports and shall submit either a non-compliance report or an approval form to the contractor. The CA shall work with the contractor and others as necessary, to correct and retest deficiencies or uncompleted items. The contractor shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner and shall notify the CA as soon as outstanding items have been corrected and resubmit an updated start-up report with a Statement of Correction on the original non-compliance report. When all requirements are satisfactorily completed, the CA shall recommend approval of the startup and prefunctional testing of each system and schedule the functional testing of the equipment or system.

- B. As functional performance testing progresses and a deficiency is identified, the CA shall discuss the issue with the executing contractor and the commissioning team.
1. When there is no dispute of the deficiency and the contractor accepts responsibility for correcting it, the CA shall document the deficiency and the contractor's response and intentions and the testing shall proceed, if possible. Corrections of minor deficiencies identified may be made by the contractor during the functional performance testing, at the discretion of the CA. Every effort shall be made or expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the commissioning effort.
  2. When the identified deficiency is corrected, the contractor shall sign the statement of correction at the bottom of the non-compliance form, certifying that the equipment is ready to be retested, and return the form to the CA. The CA shall schedule the retest of the equipment or system involved.
  3. If there is a dispute about an identified deficiency, the CA shall document the deficiency and the contractor's response and provide a copy to the contractor. Every attempt shall be made to resolve the dispute at the lowest management level possible. When the dispute resolution has been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and returns the form to the CA. The CA shall schedule the retest of the equipment or system involved. Final interpretive authority shall be the A/E. Final acceptance authority shall be the Owner.
- C. During the functional performance testing of multiple units of similar equipment, the CA will test all the installed equipment and components identified. If, under such a testing procedure, three or more, identical pieces of equipment (size along does not constitute difference) fail to perform to the requirements of the Contract Documents (mechanically or substantively) due to manufacturing defects not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the CA. In such case, the contractor shall provide the CA with the following:
1. Within one week of notification from the CA, the contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided to the CA within two weeks of the original notice.
  2. Within two weeks of the original notification, the contractor shall provide the CA and the A/E a signed and dated, written explanation of the problem, cause of failures, etc. and proposed solution, including full equipment submittals for corrective or replacement equipment, if appropriate. The proposed solution shall not be for less than the specification requirements of the original installation.
  3. When approved, two examples of the proposed solution shall be installed by the contractor and the CA shall schedule and conduct functional testing of the proposed solution. Upon completion of the functional testing of the proposed solution, the CA shall recommend the acceptance or disapproval of the proposed solution to the Owner.
  4. Upon acceptance of the proposed solution by the Owner, the contractor shall replace or repair all identical items, at their expenses and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week of approval of the proposed solution.
- D. Cost of Retesting
1. The cost for CA and/or Owner personnel to conduct the retesting of a functional performance testing requirements necessitated because a specific prefunctional or

startup test item, reported to have been successfully completed, but found to be incomplete or faulty, shall be the responsibility of the contractor.

2. For a deficiency identified during the functional testing, not related to any prefunctional checklist or start-up fault, the CA and Owner shall direct the retesting of the equipment once at "no charge" for their time. However, all costs for any subsequent retesting shall be the responsibility of the contractor.
3. Items left incomplete, which later cause deficiencies or delays during functional testing may result in back charges to the responsible party.

### 3.5 OPERATION AND MAINTENANCE (O&M) MANUALS

- A. The following O&M manual requirements do not replace O&M manual documentation requirements elsewhere in these specifications. A detailed listing of O&M requirements is listed in Section 019113.
- B. Division 22 shall compile and prepare documentation for all equipment and systems covered in Division 22 and deliver this documentation to the CM for inclusion in the O&M manuals, according to this section and Section 019113, prior to the training of owner personnel.
- C. The CA shall receive a copy of the O&M manuals for review.
- D. Operation and maintenance documentation, in hardback 3-ring loose-leaf binders except full size drawings and computer media, shall cover all Plumbing systems. Documentation shall include the following: operations and maintenance documentation directory; emergency information; operating manual; emergency information; maintenance manual; test reports; and construction documents.
- E. The operation and maintenance documentation package shall be submitted as one comprehensive package to the Owner and CA before systems start-up and commissioning, and shall be updated, revised, and completed during, and at completion of, commissioning.

### 3.6 TRAINING OF OWNER PERSONNEL

- A. The Plumbing commissioning supervisor shall be responsible for training coordination and scheduling of required training and for ensuring that all required training is completed. The CA shall oversee the content and adequacy of the training of Owner personnel.
- B. Prepare and submit a syllabus describing an overview of the program, describing how the program will be conducted, when and where meetings are to be held, names and company affiliations of lecturers, description of contents and outline for each lecture, and recommended reference material and outside reading. Obtain direction from the Owner on which operating personnel shall be instructed in each system. Proposed training schedules, materials, and lesson plans shall be submitted to the CA for review of the content and adequacy of the training of Owner personnel for commissioned equipment or systems.
- C. Plumbing Contractor – the Plumbing contractor shall have the following training responsibilities:
  1. Provide the CA with a training plan one week before the planned training.
  2. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment.

3. Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment.
4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary, and the demonstration repeated.
5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the startup technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.
6. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.

### 3.7 WRITTEN WORK PRODUCTS

- A. Written work products of Contractors shall consist of the start-up and initial checkout plan and the filled-out start-up, initial checkout and prefunctional checklists.

**END OF SECTION**

SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Ductile-iron pipe and fittings.
3. CPVC piping.
4. PVC pipe and fittings.
5. PP-R pipe and fittings.
6. Piping joining materials.
7. Encasement for piping.
8. Transition fittings.
9. Dielectric fittings.

B. Related Requirements:

1. Section 331415 "Site Water Distribution Piping" for water-service piping and water meters outside the building from source to the point where water-service piping enters the building.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Pipe and tube.
2. Fittings.
3. Joining materials.
4. Transition fittings.

B. Sustainable Design Submittals:

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B. System purging and disinfecting activities report.

- C. Field quality-control reports.

## 1.5 WARRANTY

- A. Polypropylene Piping (PP-R) Manufacturer's Warranty: Manufacturer agrees to repair or replace PP-R pipe and fittings that fail in materials or workmanship within 10 years from date of Substantial Completion.
  - 1. Warranty is to cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of the piping system due to defects in materials or manufacturing.
  - 2. Warranty is to be in effect only upon submission by the Contractor to the manufacturer of valid pressure/leak documentation indicating that the system was tested and passed the manufacturer's pressure/leak test.

## PART 2 - PRODUCTS

### 2.1 PIPING MATERIALS

- A. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372.

### 2.2 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tube: ASTM B88, Type K (ASTM B88M, Type A), ASTM B88, Type L (ASTM B88M, Type B).
- B. Annealed-Temper Copper Tube: ASTM B88, Type K (ASTM B88M, Type A), ASTM B88, Type L (ASTM B88M, Type B).
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
- G. Wrought Copper Unions: ASME B16.22.
- H. Copper-Tube, Mechanically Formed Tee Fitting: For forming T-branch on copper water tube.
  - 1. Description: Tee formed in copper tube in accordance with ASTM F2014.
- I. Grooved, Mechanical-Joint, Copper Tube Appurtenances:
  - 1. Grooved-End, Copper Fittings: ASTM B75 (ASTM B75M) copper tube or ASTM B584 bronze castings.
  - 2. Grooved-End-Tube Couplings: To fit copper-tube dimensions; rigid pattern unless otherwise indicated; gasketed fitting, EPDM-rubber gasket, UL classified per NSF 61 and NSF 372, and rated for minimum 180 deg F (80 deg C), for use with ferrous housing and steel bolts and nuts; 300 psig (2060 kPa) minimum CWP pressure rating.

- J. Copper Tube, Pressure-Seal-Joint Fittings:
  - 1. Fittings: Cast-brass, cast-bronze, or wrought-copper with EPDM O-ring seal in each end.
  - 2. Minimum 200-psig (1379-kPa) working-pressure rating at 250 deg F (121 deg C).
- K. Copper-Tube, Push-on-Joint Fittings:
  - 1. Description:
    - a. Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22.
    - b. Stainless steel teeth and EPDM-rubber, O-ring seal in each end instead of solder-joint ends.

## 2.3 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe:
  - 1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
  - 2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- B. Standard-Pattern, Mechanical-Joint Fittings:
  - 1. AWWA C110/A21.10, ductile or gray iron.
  - 2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- C. Compact-Pattern, Mechanical-Joint Fittings:
  - 1. AWWA C153/A21.53, ductile iron.
  - 2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- D. Push-on-Joint, Ductile-Iron Pipe:
  - 1. AWWA C151/A21.51.
  - 2. Push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
- E. Standard-Pattern, Push-on-Joint Fittings:
  - 1. AWWA C110/A21.10, ductile or gray iron.
  - 2. Gaskets: AWWA C111/A21.11, rubber.
- F. Compact-Pattern, Push-on-Joint Fittings:
  - 1. AWWA C153/A21.53, ductile iron.
  - 2. Gaskets: AWWA C111/A21.11, rubber.
- G. Plain-End, Ductile-Iron Pipe: AWWA C151/A21.51.
- H. Appurtenances for Grooved-End, Ductile-Iron Pipe:
  - 1. Fittings for Grooved-End, Ductile-Iron Pipe: ASTM A47/A47M, malleable-iron castings or ASTM A536, ductile-iron castings with dimensions that match pipe.
  - 2. Mechanical Couplings for Grooved-End, Ductile-Iron-Piping:

- a. AWWA C606 for ductile-iron-pipe dimensions.
- b. Ferrous housing sections.
- c. EPDM-rubber gaskets suitable for hot and cold water.
- d. Bolts and nuts.
- e. Minimum Pressure Rating:
  - 1) NPS 14 to NPS 18 (DN 350 to DN 450): 250 psig (1725 kPa).
  - 2) NPS 20 to NPS 46 (DN 500 to DN 900): 150 psig (1035 kPa).

## 2.4 CPVC PIPING

- A. CPVC Pipe: ASTM F441/F441M, with wall thickness as indicated in "Piping Applications" Article.
  - 1. CPVC Socket Fittings: ASTM F439 for Schedule 80.
  - 2. CPVC Threaded Fittings: ASTM F437, Schedule 80.
- B. CPVC Piping System: ASTM D2846/D2846M, SDR 11, pipe and socket fittings.
- C. CPVC Tubing System: ASTM D2846/D2846M, SDR 11, tube and socket fittings.

## 2.5 PVC PIPE AND FITTINGS

- A. PVC Pipe: ASTM D1785, with wall thickness as indicated in "Piping Applications" Article.
- B. PVC Socket Fittings: ASTM D2467 for Schedule 80.
- C. PVC Schedule 80 Threaded Fittings: ASTM D2464.

## 2.6 POLYPROPYLENE (PP-R) PIPE AND FITTINGS

- A. Polypropylene Pipe: ASTM F2389, pipe pressure rating to comply with temperature and pressure ratings of code requirements for the applicable service.
  - 1. Polypropylene Fittings: ASTM F2389, socket fusion, butt fusion, electrofusion, or fusion outlet fittings to be used for fusion-welded joints between pipe and fittings.
  - 2. Mechanical fittings and transition fittings to be used where transitions are made to other piping materials or to valves and appurtenances.
  - 3. Polypropylene pipe is to be unthreaded. Threaded transition fittings per ASTM F2389 to be used where a threaded connection is required.
- B. Smoke and Fire Ratings:
  - 1. Where indicated on the Drawings that a plenum-rated piping system is required, the pipe is to be wrapped and/or insulated with fiberglass or mineral wool pipe insulation, and field installed.
  - 2. The system is to have a flame spread classification of less than 25 and smoke development rating of less than 50.
  - 3. Pipe, wrap, or insulation as a system to meet the requirements of CAN/ULC-S102.2-03, ASTM E84, or UL 2846.
  - 4. For insulation required for thermal and condensation reasons, see Section 220719 "Plumbing Piping Insulation."



C. Integration of PP-R Piping Systems with Other Systems:

1. When integrating PP-R piping systems with other systems or with components not made of PP-R (for example, valves, pumps, other piping, check valves, or strainers), ensure the operating parameters for PP-R will not damage other materials in the system or vice versa.
2. Verify that all parts of the system are compatible with the medium being carried before installation. PP-R pipe does not require treatment to protect it from corrosion. Metals (ferrous and non-ferrous) in the system may be susceptible to corrosion. Provide water treatment to protect system metals.
3. Do not mix PP-R pipe with other piping systems in conditions that will cause the other system or components to fail.
4. For Domestic Hot Water Recirculation (DHWR) Systems:
  - a. When copper piping used in conjunction with PP-R in a domestic hot water recirculation system, ensure the operating conditions will not cause degradation or erosion/corrosion of the copper.
  - b. Follow the Copper Development Association guidelines (CDA Publication A4015-14/16: "Copper Tube Handbook") for sizing, temperature and flow velocity in the copper tubing.
  - c. Sustained high levels of copper in DHWR piping can damage components within the system, even PP-R.
  - d. Ensure that the maximum hot water-temperature within any part of the system/loop does not exceed 140 deg F (60 deg C). Some regulations and codes further restrict the temperature at any fixture to a maximum of 120 deg F (50 deg C). Do not exceed the temperature rating of the pipe for the operating pressure.
  - e. Maximum temperature used must not exceed the rating of the pipe for the operating pressure.
  - f. Flow rates in a domestic hot water recirculation system should not exceed 1.5 ft./sec (0.5 m/s) anywhere in the system, except in some special cases where velocities up to 3 ft./sec (1 m/s) are needed to achieve proper flow temperature.
  - g. When adding PP-R to an existing copper system in a domestic hot water recirculation application, the level of copper in the water must be tested. Do not install PP-R where levels exceed 0.1 mg/L (ppm).

D. PP-R Socket Fittings: ASTM F2389.

2.7 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B32, lead-free alloys.

D. Flux: ASTM B813, water flushable.

E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

- F. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F493.
- G. Solvent Cements for Joining PVC Piping: ASTM D2564. Include primer according to ASTM F656.
- H. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

## 2.8 ENCASEMENT FOR PIPING

- A. Standard: ASTM A674 or AWWA C105/A21.5.
- B. Form: Sheet or tube.
- C. Color: Black or natural.

## 2.9 TRANSITION FITTINGS

- A. General Requirements:
  - 1. Same size as pipes to be joined.
  - 2. Pressure rating at least equal to pipes to be joined.
  - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
- D. Plastic-to-Metal Transition Fittings:
  - 1. Description:
    - a. CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
    - b. One end with threaded brass insert and one solvent-cement-socket or threaded end.
- E. Plastic-to-Metal Transition Unions:
  - 1. Description:
    - a. CPVC or PVC four-part union.
    - b. Brass or stainless steel threaded end.
    - c. Solvent-cement-joint or threaded plastic end.
    - d. Rubber O-ring.
    - e. Union nut.

## 2.10 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:

1. Standard: ASSE 1079.
  2. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
  3. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
1. Standard: ASSE 1079.
  2. Factory-fabricated, bolted, companion-flange assembly.
  3. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C)].
  4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
1. Nonconducting materials for field assembly of companion flanges.
  2. Pressure Rating: 150 psig (1035 kPa).
  3. Gasket: Neoprene or phenolic.
  4. Bolt Sleeves: Phenolic or polyethylene.
  5. Washers: Phenolic with steel backing washers.
- E. Dielectric Nipples:
1. Standard: IAPMO PS 66.
  2. Electroplated steel nipple complying with ASTM F1545.
  3. Pressure Rating and Temperature: 300 psig (2070 kPa) at 225 deg F (107 deg C).
  4. End Connections: Male threaded or grooved.
  5. Lining: Inert and noncorrosive, propylene.

## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building-service piping, NPS 3 (DN 80) and smaller, shall be one of the following:
1. Annealed-temper copper tube, ASTM B88, Type K (ASTM B88M, Type A); wrought-copper, solder-joint fittings; and brazed joints.
  2. PVC, Schedule 80; socket fittings; and solvent-cemented joints.
  3. Polypropylene (PP-R), SDR 11 pipe and socket fusion, butt fusion, fusion outlet, or electrofusion fittings and joints.
- E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 (DN 100 to DN 200) and larger, shall be one of the following:
1. Mechanical-joint, ductile-iron pipe; standard pattern, mechanical-joint fittings; and mechanical joints.
  2. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.

- F. Under-building-slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12 (DN 150 to DN 300), shall be one of the following:
1. Mechanical-joint, ductile-iron pipe; standard-pattern, mechanical-joint fittings; and mechanical joints.
  2. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
- G. Under-building-slab, domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:
1. Drawn-temper or annealed-temper copper tube, ASTM B88, Type L (ASTM B88M, Type B); wrought-copper, solder-joint fittings; and brazed joints.
  2. PVC, Schedule 80; socket fittings; and solvent-cemented joints.
  3. Polypropylene (PP-R), SDR 11 pipe and socket fusion, butt fusion, fusion outlet, or electrofusion fittings and joints.
- H. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:
1. Drawn-temper copper tube, ASTM B88, Type L (ASTM B88M, Type B) cast or wrought-copper, solder-joint fittings; and soldered joints.
  2. Drawn-temper copper tube, ASTM B88, Type L (ASTM B88M, Type B) copper pressure-seal-joint fittings; and pressure-sealed joints.
  3. CPVC, Schedule 80; socket fittings; and solvent-cemented joints.
  4. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
  5. CPVC Tubing System: CPVC tube; CPVC socket fittings; and solvent-cemented joints.
  6. PVC,; socket fittings; and solvent-cemented joints.
  7. Polypropylene (PP-R), SDR 11 pipe and socket fusion, butt fusion, fusion outlet, or electrofusion fittings and joints.
- I. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:
1. Drawn-temper copper tube, ASTM B88, Type L (ASTM B88M, Type B); cast- or wrought-copper, solder-joint fittings; and soldered joints.
  2. Drawn-temper copper tube, ASTM B88, Type L (ASTM B88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints.
  3. Drawn-temper copper tube, ASTM B88, Type L (ASTM B88M, Type B); grooved-joint, copper-tube appurtenances; and grooved joints.
  4. CPVC, Schedule 80; socket fittings; and solvent-cemented joints.
  5. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
  6. PVC, Schedule 80; socket fittings; and solvent-cemented joints.
  7. Polypropylene (PP-R), SDR 11 pipe and socket fusion, butt fusion, fusion outlet, or electrofusion fittings and joints.
- J. Aboveground domestic water piping, NPS 5 to NPS 8 (DN 125 to DN 200), shall be one of the following:
1. Drawn-temper copper tube, ASTM B88, Type L (ASTM B88M, Type B) cast- or wrought-copper, solder-joint fittings; and soldered joints.
  2. Drawn-temper copper tube, ASTM B88, Type L (ASTM B88M, Type B); grooved-joint, copper-tube appurtenances; and grooved joints.
  3. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
  4. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

5. Polypropylene (PP-R) SDR 11 pipe and socket fusion, butt fusion, fusion outlet, or electrofusion fittings and joints.
- K. Aboveground, combined domestic water-service and fire-service-main piping, NPS 6 to NPS 12 (DN 150 to (DN 300), shall be one of the following:
  1. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.

### 3.2 EARTHWORK

- A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

### 3.3 INSTALLATION OF PIPING

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A674 or AWWA C105/A21.5.
- E. Install valves according to the following:
  1. Section 220523.12 "Ball Valves for Plumbing Piping."
  2. Section 220523.13 "Butterfly Valves for Plumbing Piping."
  3. Section 220523.14 "Check Valves for Plumbing Piping."
  4. Section 220523.15 "Gate Valves for Plumbing Piping."
- F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."
- G. Install domestic water piping level and plumb.
- H. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- J. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

- K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- L. Install piping to permit valve servicing.
- M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- N. Install piping free of sags and bends.
- O. Install fittings for changes in direction and branch connections.
- P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- Q. Install pressure gauges on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gauges in Section 220519 "Meters and Gages for Plumbing Piping."
- R. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."
- S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

### 3.4 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Braze Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."

- F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
- G. Push-on Joints for Copper Tubing: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.
- H. Extruded-Tee Connections: Form tee in copper tube according to ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- I. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.
- J. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- K. Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. Square cut groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- L. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- M. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
  2. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.
  3. PVC Piping: Join according to ASTM D2855.
- N. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

### 3.5 INSTALLATION OF TRANSITION FITTINGS

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
  1. Fittings for NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
  2. Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings or unions.

### 3.6 INSTALLATION OF DIELECTRIC FITTINGS

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 (DN 50)] and Smaller: Use dielectric couplings or nipples.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.
- D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

### 3.7 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for hangers, supports, and anchor devices in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- C. Install hangers with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Install vinyl-coated hangers for CPVC, PVC, and PP piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- E. Support horizontal piping within 12 inches (300 mm) of each fitting.
- F. Support vertical runs of piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- G. Support vertical runs of CPVC, PVC, and PP-R piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- H. Support vertical runs of PEX tubing to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

### 3.8 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
  - 1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.



2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

### 3.9 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

### 3.10 ADJUSTING

- A. Perform the following adjustments before operation:
  1. Close drain valves, hydrants, and hose bibbs.
  2. Open shutoff valves to fully open position.
  3. Open throttling valves to proper setting.
  4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
    - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
    - b. Adjust calibrated balancing valves to flows indicated.
  5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
  6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
  7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
  8. Check plumbing specialties and verify proper settings, adjustments, and operation.

### 3.11 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  1. Piping Inspections:
    - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
    - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
      - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

- c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
- d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
- b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
- c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
- d. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
- e. Hydrostatic testing and documentation of test results for polypropylene piping to be in accordance with the manufacturer's instructions and submitted to the manufacturer upon successful completion per warranty requirements.
- f. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
- g. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

### 3.12 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

- 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
- 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
  - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
  - b. Fill and isolate system according to either of the following:
    - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
    - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
  - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
  - d. Repeat procedures if biological examination shows contamination.
  - e. Submit water samples in sterile bottles to authorities having jurisdiction.

- B. Clean non-potable domestic water piping as follows:
  - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
  - 2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
    - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION 22 11 16

## SECTION 22 11 19

### DOMESTIC WATER PIPING SPECIALTIES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

###### A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Temperature-actuated, water mixing valves.
6. Strainers for domestic water piping.
7. Outlet boxes.
8. Hose bibbs.
9. Wall hydrants.
10. Post hydrants.
11. Roof hydrants.
12. Drain valves.
13. Water-hammer arresters.
14. Flexible connectors.

###### B. Related Requirements:

1. Section 220519 "Meters and Gauges for Plumbing Piping" for thermometers, pressure gauges, and flow meters in domestic water piping.
2. Section 221116 "Domestic Water Piping" for water meters.
3. Section 223200 "Domestic Water Filtration Equipment" for water filters in domestic water piping.
4. Section 224300 "Healthcare Plumbing Fixtures" for thermostatic mixing valves for sitz baths, thermostatic mixing-valve assemblies for hydrotherapy equipment, and outlet boxes for dialysis equipment.
5. Section 224500 "Emergency Plumbing Fixtures" for water tempering equipment.

##### 1.3 DEFINITIONS

- A. AMI: Advanced Metering Infrastructure.
- B. AMR: Automatic Meter Reading.
- C. FKM: A family of fluoroelastomer materials defined by ASTM D1418.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For domestic water piping specialties.
  - 1. Include diagrams for power, signal, and control wiring.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Test and inspection reports.
- B. Field quality-control reports.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

### PART 2 - PRODUCTS

#### 2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

#### 2.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa) unless otherwise indicated.

#### 2.3 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers :
  - 1. Standard: ASSE 1001.
  - 2. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), as required to match connected piping.
  - 3. Body: Bronze.
  - 4. Inlet and Outlet Connections: Threaded.
  - 5. Finish: Rough bronze.
- B. Hose-Connection Vacuum Breakers :
  - 1. Standard: ASSE 1011.
  - 2. Body: Bronze, nonremovable, with manual drain.
  - 3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
  - 4. Finish: Chrome or nickel plated.

## 2.4 BACKFLOW PREVENTERS

- A. Intermediate Atmospheric-Vent Backflow Preventers:
  - 1. Standard: ASSE 1012.
  - 2. Operation: Continuous-pressure applications.
  - 3. Size: NPS 1/2 (DN 15) or NPS 3/4 (DN 20).
  - 4. Body: Bronze.
  - 5. End Connections: Union, solder joint.
  - 6. Finish: Rough bronze.
  
- B. Reduced-Pressure-Principle Backflow Preventers: Water Service Entrance
  - 1. Standard: ASSE 1013.
  - 2. Operation: Continuous-pressure applications.
  - 3. Pressure Loss: 12 psig (83 kPa) maximum, through middle third of flow range.
  - 4. Size: See drawings.
  - 5. Design Flow Rate: See drawings.
  - 6. Body: Stainless steel for NPS 2-1/2 (DN 65) and larger.
  - 7. End Connections: Flanged for NPS 2-1/2 (DN 65) and larger.
  - 8. Configuration: Designed for horizontal, straight-through flow.
  - 9. Accessories:
    - a. Valves NPS 2-1/2 (DN 65) and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
    - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
  
- C. Double-Check, Backflow-Prevention Assemblies: Fire Service Entrance
  - 1. Standard: ASSE 1015.
  - 2. Operation: Continuous-pressure applications unless otherwise indicated.
  - 3. Pressure Loss: 5 psig (35 kPa) maximum, through middle third of flow range.
  - 4. Size: See drawings.
  - 5. Design Flow Rate: See drawings.
  - 6. Body: Stainless steel for NPS 2-1/2 (DN 65) and larger.
  - 7. End Connections: Flanged for NPS 2-1/2 (DN 65) and larger.
  - 8. Configuration: Designed for vertical flow.
  - 9. Accessories:
    - a. Valves NPS 2-1/2 (DN 65) and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
  
- D. Hose-Connection Backflow Preventers:
  - 1. Standard: ASSE 1052.
  - 2. Operation: Up to 10-foot head of water (30-kPa) back pressure.
  - 3. Inlet Size: NPS 3/4 (DN 20).
  - 4. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
  - 5. Capacity: At least 3-gpm (0.19-L/s) flow.

## 2.5 WATER PRESSURE-REDUCING VALVES

- A. Water Regulators:
  - 1. Standard: ASSE 1003.
  - 2. Pressure Rating: Initial working pressure of 150 psig (1035 kPa).
  - 3. Body: Bronze for NPS 2 (DN 50) and smaller; bronze for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).
  - 4. Valves for Booster Heater Water Supply: Include integral bypass.
  - 5. End Connections: Threaded or solder for NPS 2 (DN 50) and smaller; flanged or solder for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).

## 2.6 BALANCING VALVES

- A. Copper-Alloy Calibrated Balancing Valves :
  - 1. Type: Ball or Y-pattern globe valve with two readout ports and memory-setting indicator.
  - 2. Body: Brass or bronze.
  - 3. Size: Same as connected piping, but not larger than NPS 2 (DN 50).
  - 4. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.
  
- B. Memory-Stop Balancing Valves:
  - 1. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
  - 2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
  - 3. Size: NPS 2 (DN 50) or smaller.
  - 4. Body: Copper alloy.
  - 5. Port: Standard or full port.
  - 6. Ball: Chrome-plated brass or stainless steel.
  - 7. Seats and Seals: Replaceable.
  - 8. End Connections: Solder joint or threaded.
  - 9. Handle: Vinyl-covered steel with memory-setting device.

## 2.7 TEMPERATURE-ACTUATED, WATER MIXING VALVES

- A. Water-Temperature Limiting Devices:
  - 1. Standard: ASSE 1070.
  - 2. Pressure Rating: 125 psig (860 kPa).
  - 3. Type: Thermostatically controlled, water mixing valve.
  - 4. Material: Bronze body with corrosion-resistant interior components.
  - 5. Connections: Threaded inlets and outlet.
  - 6. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
  - 7. Valve Finish: Chrome plated.
  
- B. Individual-Fixture, Water Tempering Valves:
  - 1. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
  - 2. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
  - 3. Material: Bronze body with corrosion-resistant interior components.
  - 4. Temperature Control: Adjustable.
  - 5. Connections: Threaded inlets and outlet.
  - 6. Finish: Chrome plated.

## 2.8 STRAINERS FOR DOMESTIC WATER PIPING

- A. Y-Pattern Strainers :
  - 1. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
  - 2. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron for NPS 2-1/2 (DN 65) and larger.
  - 3. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
  - 4. Screen: Stainless steel with round perforations unless otherwise indicated.
  - 5. Perforation Size:
    - a. Strainers NPS 2 (DN 50) and Smaller: 0.020 inch (0.51 mm).
    - b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inch (1.14 mm).
    - c. Strainers NPS 5 (DN 125) and Larger: 0.10 inch (2.54 mm).

6. Drain: Pipe plug.

## 2.9 OUTLET BOXES

### A. Clothes Washer Outlet Boxes:

1. Mounting: Recessed
2. Material and Finish: Enameled-steel, epoxy-painted-steel, or plastic box and faceplate.
3. Faucet: Combination valved fitting or separate hot- and cold-water valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
4. Drain Outlet Connection: NPS 2 (DN 50).
5. Accessory: Water hammer arresters.
6. Supply Shutoff Fittings: NPS 1/2 (DN 15) gate, globe, or ball valves and NPS 1/2 (DN 15) copper, water tubing.
7. Drain: NPS 2 (DN 50) standpipe and P-trap for direct waste connection to drainage piping.
8. Inlet Hoses: Two 60-inch- (1500-mm-) long, rubber, household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
9. Drain Hose: One 48-inch- (1200-mm-) long, rubber, household clothes washer drain hose with hooked end.

### B. Icemaker Outlet Boxes:

1. Mounting: Recessed.
2. Material and Finish: Enameled-steel, epoxy-painted-steel, or plastic box and faceplate.
3. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 (DN 15) or smaller copper tube outlet.
4. Accessory: Water hammer arrestor.
5. Supply Shutoff Fitting: NPS 1/2 (DN 15) gate, globe, or ball valve and NPS 1/2 (DN 15) copper, water tubing.

## 2.10 HOSE BIBBS

### A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 (DN 15 or DN 20) threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig (860 kPa).
7. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Rough bronze
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Wheel handle.
14. Include operating key with each operating-key hose bibb.
15. Include wall flange with each chrome- or nickel-plated hose bibb.



## 2.11 WALL HYDRANTS

### A. Nonfreeze Wall Hydrants:

1. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig (860 kPa).
3. Operation: Loose key.
4. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
5. Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25).
6. Outlet, Concealed: With integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
7. Box: Deep, flush mounted with cover.
8. Box and Cover Finish: Polished nickel bronze.
9. Nozzle and Wall-Plate Finish: Polished nickel bronze.
10. Operating Keys(s): One with each wall hydrant.

### B. Nonfreeze Vacuum Breaker Wall Hydrants:

1. Standard: ASSE 1019, Type A or Type B.
2. Type: Automatic draining with integral air-inlet valve.
3. Classification: Type A, for automatic draining with hose removed or Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
4. Pressure Rating: 125 psig (860 kPa).
5. Operation: Loose key
6. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
7. Inlet: NPS 1/2 or NPS 3/4 (DN 15 or DN 20).
8. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

## 2.12 POST HYDRANTS

### A. Nonfreeze, Draining-Type Post Hydrants:

1. Standard: ASME A112.21.3M.
2. Type: Nonfreeze, exposed-outlet post hydrant.
3. Operation: Loose key.
4. Casing and Operating Rod: Of at least length required for burial of valve below frost line.
5. Casing: Bronze with casing guard.
6. Inlet: NPS 3/4 (DN 20).
7. Outlet: Garden-hose thread complying with ASME B1.20.7.
8. Drain: Designed with hole to drain into ground when shut off.
9. Vacuum Breaker:
  - a. Nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
  - b. Garden-hose thread complying with ASME B1.20.7 on outlet.
10. Operating Key(s): One with each loose-key-operation wall hydrant.

## 2.13 ROOF HYDRANTS

### A. Nonfreeze, Draining-Type Roof Hydrants:

1. Standard: ASME A112.21.3M.
2. Type: Nonfreeze, exposed-outlet roof hydrant with coated cast-iron head and lift handle with lock option. Provide with deck flange and under deck clamp.

3. Casing and Operating Rod: Bronze interior parts, galvanized-steel casing, and bronze valve housing designed with hole to drain.
4. Inlet: NPS 3/4 (DN 20).
5. Outlet: Garden-hose thread complying with ASME B1.20.7.
6. Vacuum Breaker:
  - a. Nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
  - b. Garden-hose thread complying with ASME B1.20.7 on outlet.

## 2.14 DRAIN VALVES

### A. Ball-Valve-Type, Hose-End Drain Valves :

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

## 2.15 WATER-HAMMER ARRESTERS

### A. Water-Hammer Arresters:

1. Standard: ASSE 1010 or PDI-WH 201.
2. Type: Metal bellows.
3. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

## 2.16 FLEXIBLE CONNECTORS

### A. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig (1380 kPa).
2. End Connections NPS 2 (DN 50) and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged copper alloy.

### B. Stainless Steel-Hose Flexible Connectors: Corrugated-stainless steel tubing with stainless steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig (1380 kPa).
2. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF PIPING SPECIALTIES

- A. Backflow Preventers: Install in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
  - 1. Locate backflow preventers in same room as connected equipment or system.
  - 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
  - 3. Do not install bypass piping around backflow preventers.
- B. Water Regulators: Install with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gauges on inlet and outlet.
- C. Automatic Water Shutoff Valves: Test for signal strength before valve installation. Install automatic shutoff valve downstream from main domestic water shutoff valve. Install valve controller in an accessible location with sensors in areas where water is likely to accumulate.
- D. Balancing Valves: Install in locations where they can easily be adjusted. Set at indicated design flow rates.
- E. Temperature-Actuated, Water Mixing Valves: Install with check stops or shutoff valves on inlets and with shutoff valve on outlet.
  - 1. Install cabinet-type units recessed in or surface mounted on wall as specified.
- F. Y-Pattern Strainers: For water, install on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.
- G. Outlet Boxes: Install boxes recessed in wall or surface mounted on wall. Install 1-1/2-by-3-1/2-inch (38-by-89-mm) fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."
- H. Nonfreeze, Draining-Type Post Hydrants: Install with 1 cu. yd. (0.75 cu. m) of crushed gravel around drain hole. Set post hydrants in concrete paving or in 1 cu. ft. (0.03 cu. m) of concrete block at grade.
- I. Nonfreeze, Nondraining-Type Post Hydrants: Set in concrete or pavement.
- J. Nonfreeze, Draining-Type Roof Hydrants: Install with drain connection piped to nearest floor drain or to the exterior.
- K. Water-Hammer Arresters: Install in water piping in accordance with PDI-WH 201.
- L. Drainage-Type, Trap-Seal Primer Device: Install as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

### 3.2 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

### 3.3 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

### 3.4 CONTROL CONNECTIONS

- A. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

### 3.5 IDENTIFICATION

- A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
  - 1. Vacuum breakers.
  - 2. Backflow preventers.
  - 3. Water pressure-reducing valves.
  - 4. Balancing valves.
  - 5. Temperature-actuated, water mixing valves.
  - 6. Outlet boxes.
  - 7. Wall hydrants.
  - 8. Post hydrants.
  - 9. Roof hydrants.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

### 3.6 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

- D. Adjust each reduced-pressure-principle backflow preventer and double-check, backflow-prevention assembly in accordance with manufacturer's written instructions, authorities having jurisdiction and the device's reference standard.

### 3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
  - 1. Test each reduced-pressure-principle backflow preventer and double-check, backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.
  - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm unit operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 22 11 19

SECTION 22 11 23.13

DOMESTIC-WATER PACKAGED BOOSTER PUMPS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

- A. Section Includes:
  - 1. Multiplex, variable-speed booster pumps.
- B. Related Requirements:
  - 1. Section 221123 "Domestic Water Pumps" for domestic-water circulation pumps.

1.4 DEFINITIONS

- A. PID: Proportional Integral Derivative.
- B. VFC: Variable-frequency controller.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, and dimensions of individual components and profiles.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For booster pumps.
  - 1. Include plans, elevations, sections, and details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.

- C. Delegated-Design Submittal: For domestic-water packaged booster pumps.
  - 1. Include design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: Certificates, for booster pumps, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For booster pumps to include in emergency, operation, and maintenance manuals.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Retain protective coatings and flange's protective covers during storage.

#### 1.9 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.
- B. Seismic Performance: Booster pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the booster pump will remain in place without separation of any parts from the booster pump when subjected to the seismic forces specified and the booster pump will be fully operational after the seismic event."

#### 2.2 MULTIPLEX, VARIABLE-SPEED BOOSTER PUMPS

- A. Description: Factory-assembled and -tested, fluid-handling system for domestic water, with pumps, piping, valves, specialties, and controls, and mounted on base.

- B. Pumps:
1. Type: End suction as defined in HI 1.1-1.2 and HI 1.3 for end-suction, frame-mounted, separately coupled, single-stage, overhung-impeller, centrifugal pump.
  2. Casing: Radially split; bronze.
  3. Impeller: Closed, ASTM B584 cast bronze; statically and dynamically balanced and keyed to shaft.
  4. Shaft and Shaft Sleeve: Stainless-steel shaft, with copper-alloy shaft sleeve and deflector.
  5. Seal: Mechanical.
  6. Bearing: Grease-lubricated or pre-greased, permanently shielded ball type.
  7. Coupling: Flexible, with metal guard.
- C. Motors: Single speed, with grease-lubricated or pre-greased, permanently shielded, ball-bearings. Select motors that will not overload through full range of pump performance curve.
- D. Piping: Copper tube and copper fittings.
- E. Valves:
1. Shutoff Valves NPS 2 (DN 50) and Smaller: Gate valve or two-piece, full-port ball valve, in each pump's suction and discharge piping.
  2. Shutoff Valves NPS 2-1/2 (DN 65) and Larger: Gate valve or lug-type butterfly valve, in each pump's suction and discharge piping and in inlet and outlet headers.
  3. Check Valves NPS 2 (DN 50) and Smaller: Silent or swing type in each pump's discharge piping.
  4. Check Valves NPS 2-1/2 (DN 65) and Larger: Silent type in each pump's discharge piping.
  5. Thermal-Relief Valve: Temperature-and-pressure relief type in pump's discharge header piping.
- F. Dielectric Fittings: With insulating material to isolate joined dissimilar metals.
- G. VFC: Comply with Section 262923 "Variable-Frequency Motor Controllers."
- H. VFC: Serving each pump in pump array.
1. Manufactured Units: Pulse-width modulated; constant torque and variable torque for inverter-duty motors.
  2. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
  3. Unit Operating Requirements:
    - a. Internal Adjustability:
      - 1) Minimum Speed: 5 to 25 percent of maximum rpm.
      - 2) Maximum Speed: 80 to 100 percent of maximum rpm.
      - 3) Acceleration: 0.1 to 999.9 seconds.
      - 4) Deceleration: 0.1 to 999.9 seconds.
      - 5) Current Limit: 30 to minimum of 150 percent of maximum rating.
    - b. Self-Protection and Reliability Features:
      - 1) Surge suppression.
      - 2) Loss of input signal protection.



- 3) Under- and overvoltage trips.
  - 4) VFC and motor overload/overtemperature protection.
  - 5) Critical frequency rejection.
  - 6) Loss-of-phase protection.
  - 7) Reverse-phase protection.
  - 8) Motor-overtemperature fault.
- c. Bidirectional autospeed search.
  - d. Torque boost.
  - e. Motor temperature compensation at slow speeds.
    - 1) Panel-mounted operator station.
    - 2) Historical logging information and displays.
    - 3) Digital indicating devices.
  - f. Control Signal Interface: Electric.
  - g. Proportional Integral Derivative (PID) control interface.
  - h. DDC System for HVAC Protocols for Network Communications: ASHRAE 135.
4. Line Conditioning:
- a. Input line conditioning.
  - b. Output filtering.
  - c. EMI/RFI filtering.
5. Bypass Systems:
- a. Bypass Mode: Field-selectable automatic or manual.
  - b. Bypass Controller: Two-contactor style, with bypass and output isolating contactors and isolating switch.
  - c. Bypass Contactor Configuration: Full-voltage (across the line) type.
6. Instrumentation: Suction and discharge pressure gauges.
7. Lights: Running light for each pump.
8. Alarm Signal Device: Sounds alarm when backup pumps are operating.
- a. Time Delay: Controls alarm operation; adjustable from 1 to 300 seconds, with manual reset.
9. Thermal-bleed cutoff.
10. Low-suction-pressure cutout.
11. High-suction-pressure cutout.
12. Low-discharge-pressure cutout.
13. High-discharge-pressure cutout.
14. Direct Digital Control (DDC) System for HVAC: Provide auxiliary contacts for interface to DDC system. DDC systems are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC." Include the following:
- a. On-off status of each pump.
  - b. Alarm status.
- I. Base: Structural steel.
- J. Capacities and Characteristics: Refer to schedule on drawings.

## 2.3 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.
  - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
  - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in NFPA 70.

## 2.4 SOURCE QUALITY CONTROL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. ASME Compliance: Comply with ASME B31.9 for piping.
- C. UL Compliance for Packaged Pumping Systems:
  - 1. UL 508, "Industrial Control Equipment."
  - 2. UL 508A, "Industrial Control Panels."
  - 3. UL 778, "Motor-Operated Water Pumps."
  - 4. UL 1995, "Heating and Cooling Equipment."
- D. Booster pumps shall be listed and labeled as packaged pumping systems by testing agency acceptable to authorities having jurisdiction.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in for booster pumps to verify actual locations of piping connections before booster-pump installation.

### 3.2 INSTALLATION

- A. Booster-Pump Mounting:
  - 1. Install booster pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
  - 2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Support connected domestic-water piping so weight of piping is not supported by booster pumps.

### 3.3 PIPING CONNECTIONS

- A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Booster-Pump Piping Connections: Connect domestic-water piping to booster pumps. Install suction and discharge pipe equal to or greater than size of system suction and discharge headers.
  - 1. Install shutoff valves on piping connections to booster-pump suction and discharge headers. Install ball, butterfly, or gate valves same size as suction and discharge headers. Comply with requirements for general-duty valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."
  - 2. Install union, flanged, or grooved-joint connections on suction and discharge headers at connection to domestic-water piping. Comply with requirements for unions and flanges specified in Section 221116 "Domestic Water Piping."
  - 3. Install valved bypass, same size as and between piping, at connections to booster-pump suction and discharge headers. Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."
  - 4. Install flexible connectors, same size as piping, on piping connections to booster-pump suction and discharge headers. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."
  - 5. Where installing piping adjacent to booster pumps, allow space for service and maintenance.

### 3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

### 3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

### 3.6 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
  - 1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (13 mm) high.

### 3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
  - 1. Perform visual and mechanical inspection.
  - 2. Leak Test: After installation, charge booster pump and test for leaks. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: After electrical circuitry has been energized, start booster pumps to confirm proper motor rotation and booster-pump operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Pumps and controls will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

### 3.8 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.

### 3.9 ADJUSTING

- A. Adjust booster pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust pressure set points.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting booster pump to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

### 3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain booster pumps.

END OF SECTION 22 11 23.13

SECTION 22 11 23.21

INLINE, DOMESTIC-WATER PUMPS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

- A. Section Includes:
  - 1. Vertically mounted, in-line, close-coupled centrifugal pumps.
- B. Related Requirements:
  - 1. Section 221123.13 "Domestic-Water Packaged Booster Pumps" for booster systems.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction materials, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Detail pumps and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Structural members to which pumps will be attached.
  - 2. Size and location of initial access modules for acoustical tile.
- B. Seismic Qualification Data: Certificates, for inline, domestic-water pumps, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For inline, domestic-water pumps to include in operation and maintenance manuals.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written instructions for handling.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. UL Compliance: UL 778 for motor-operated water pumps.
- C. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.
- D. Seismic Performance: Inline, domestic-water pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  2. Component Importance Factor: 1.5.

#### 2.2 VERTICALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

- A. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted vertical.
- B. Pump Construction:
1. Casing: Radially split bronze, with wear rings and threaded companion-flange connections for pumps with NPS 2 (DN 50) pipe connections and flanged connections for pumps with NPS 2-1/2 (DN 65) pipe connections.

2. Impeller: Bronze or brass, statically and dynamically balanced, closed, and keyed to shaft.
  3. Shaft and Shaft Sleeve: Stainless-steel shaft, with copper-alloy shaft sleeve.
  4. Shaft Coupling: Flexible or rigid type if pump is provided with coupling.
  5. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.
  6. Bearings: Oil-lubricated; bronze-journal or ball type.
  7. Minimum Working Pressure: 175 psig (1200 kPa).
  8. Continuous Operating Temperature: 225 deg F (107 deg C).
- C. Motor: Single speed, with grease-lubricated ball bearings; rigidly mounted to pump casing.

## 2.3 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in for domestic-water-piping system to verify actual locations of piping connections before pump installation.

### 3.2 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Mount pumps in orientation complying with manufacturer's written instructions.
- C. Pump Mounting:
1. Install vertically mounted, in-line, close-coupled centrifugal pumps with cast-iron base mounted on concrete base using vibration isolation type and deflection as specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment." Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
  2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
  3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  5. Install anchor bolts to elevations required for proper attachment to supported equipment.

- D. Install continuous-thread hanger rods and vibration isolation of size required to support pump weight.
  - 1. Comply with requirements for vibration isolation devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment." Fabricate brackets or supports as required.
  - 2. Comply with requirements for hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- E. Install pressure switches in water-supply piping.
- F. Install thermostats in hot-water return piping.
- G. Install time-delay relays in piping between water heaters and hot-water storage tanks.

### 3.3 PIPING CONNECTIONS

- A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to inline, domestic-water pumps, allow space for service and maintenance.
- C. Connect domestic-water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
  - 1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
    - a. Vertically mounted, in-line, close-coupled centrifugal pumps.
    - b. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."
- D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for strainers specified in Section 221119 "Domestic Water Piping Specialties." Comply with requirements for valves specified in the following:
  - 1. Section 220523.12 "Ball Valves for Plumbing Piping."
  - 2. Section 220523.13 "Butterfly Valves for Plumbing Piping."
  - 3. Section 220523.14 "Check Valves for Plumbing Piping."
  - 4. Section 220523.15 "Gate Valves for Plumbing Piping."
  - 5. Install pressure gauge and snubber at suction of each pump and pressure gauge and snubber at discharge of each pump. Install at integral pressure-gauge tapings where provided or install pressure-gauge connectors in suction and discharge piping around pumps. Comply with requirements for pressure gauges and snubbers specified in Section 220519 "Meters and Gages for Plumbing Piping."

### 3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring between temperature controllers and devices.



### 3.5 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment" for identification of pumps.

### 3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Inline, domestic-water pump will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

### 3.7 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. Check piping connections for tightness.
  - 3. Clean strainers on suction piping.
  - 4. Set pressure switches, thermostats, and time-delay relays for automatic starting and stopping operation of pumps.
  - 5. Perform the following startup checks for each pump before starting:
    - a. Verify bearing lubrication.
    - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    - c. Verify that pump is rotating in the correct direction.
  - 6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
  - 7. Start motor.
  - 8. Open discharge valve slowly.
  - 9. Adjust temperature settings on thermostats.
  - 10. Adjust timer settings.

3.8 ADJUSTING

- A. Adjust inline, domestic-water pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust initial temperature set points.
- C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 22 11 23.21

## SECTION 22 13 16

### SANITARY WASTE AND VENT PIPING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

###### A. Section Includes:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. ABS pipe and fittings.
3. PVC pipe and fittings.
4. Specialty pipe fittings.

###### B. Related Requirements:

1. Section 221313 "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.
2. Section 221329 "Sanitary Sewerage Pumps" for effluent and sewage pumps.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and elevations, or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.
- B. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.
  1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

## 1.5 WARRANTY

- A. Listed manufacturers to provide labeling and warranty of their respective products.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation are capable of withstanding the following minimum working pressure unless otherwise indicated:
  - 1. Soil, Waste, and Vent Piping: 10 ft. head of water (30 kPa head of water).
- B. Seismic Performance: Soil, waste, and vent piping and support and installation to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7. See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment":
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  - 2. Component Importance Factor: 1.5.

### 2.2 PIPING MATERIALS

- A. Piping materials to bear label, stamp, or other markings of specified testing agency.
- B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

### 2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings:
  - 1. Marked with CISPI collective trademark.
  - 2. ASTM A74, service and extra-heavy cast iron.
- B. Gaskets: ASTM C564, rubber.
- C. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

### 2.4 ABS PIPE AND FITTINGS

- A. NSF Marking: Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.
- B. Solid-Wall ABS Pipe: ASTM D2661, Schedule 40.
- C. ABS Socket Fittings: ASTM D2661, made in accordance with ASTM D3311, drain, waste, and vent patterns.

- D. Solvent Cement: ASTM D2235.

## 2.5 PVC PIPE AND FITTINGS

- A. Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic drain, waste, and vent piping and "NSF-sewer" marking for plastic sewer piping.
- B. Solid-Wall PVC Pipe: ASTM D2665 drain, waste, and vent.
- C. PVC Socket Fittings: ASTM D2665, made in accordance with ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- D. Adhesive Primer: ASTM F656.
- E. Solvent Cement: ASTM D2564.

## 2.6 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
  - 1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and compatible with pipes to be joined.
  - 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
  - 3. Unshielded, Nonpressure Transition Couplings:
    - a. Standard: ASTM C1173.
    - b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
    - c. End Connections: Same size as and compatible with pipes to be joined.
    - d. Sleeve Materials:
      - 1) For Cast-Iron Soil Pipes: ASTM C564, rubber.
      - 2) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926 PVC.
      - 3) For Dissimilar Pipes: ASTM D5926 PVC or other material compatible with pipe materials being joined.
  - 4. Shielded, Nonpressure Transition Couplings:
    - a. Standard: ASTM C1460.
    - b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
    - c. End Connections: Same size as and compatible with pipes to be joined.
  - 5. Pressure Transition Couplings:
    - a. Standard: AWWA C219.
    - b. Description: Metal sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
    - c. Center-Sleeve Material: Manufacturer's standard Carbon steel.
    - d. Gasket Material: Natural or synthetic rubber.
    - e. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:
  - a. Description:
    - 1) Standard: ASSE 1079.
    - 2) Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
    - 3) End Connections: Solder-joint copper alloy and threaded ferrous.
3. Dielectric Flanges:
  - a. Description:
    - 1) Standard: ASSE 1079.
    - 2) Factory-fabricated, bolted, companion-flange assembly.
    - 3) Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
    - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
4. Dielectric-Flange Insulating Kits:
  - a. Description:
    - 1) Nonconducting materials for field assembly of companion flanges.
    - 2) Pressure Rating: 150 psig (1035 kPa).
    - 3) Gasket: Neoprene or phenolic.
    - 4) Bolt Sleeves: Phenolic or polyethylene.
    - 5) Washers: Phenolic with steel backing washers.
5. Dielectric Nipples:
  - a. Description:
    - 1) Standard: IAPMO PS 66.
    - 2) Electroplated steel nipple.
    - 3) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
    - 4) End Connections: Male threaded or grooved.
    - 5) Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
  2. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment".
- K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
  2. Use long-turn, double Y-branch, and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
    - a. Straight tees, elbows, and crosses may be used on vent lines.
  3. Do not change direction of flow more than 90 degrees.
  4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
    - a. Reducing size of waste piping in direction of flow is prohibited.
- L. Lay buried building waste piping beginning at low point of each system.
1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
  2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
  3. Maintain swab in piping and pull past each joint as completed.
- M. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Waste: Two percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; one percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
  2. Horizontal Sanitary Waste Piping: One percent downward in direction of flow.
  3. Vent Piping: One percent down toward vertical fixture vent or toward vent stack.
- N. Install cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- O. Install steel piping in accordance with applicable plumbing code.
- P. Install aboveground PVC piping in accordance with ASTM D2665.
- Q. Plumbing Specialties:
1. Install backwater valves in sanitary waster gravity-flow piping.
    - a. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."
  2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
    - a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
    - b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
  3. Install drains in sanitary waste gravity-flow piping.
    - a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."
- R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- S. Install sleeves for piping penetrations of walls, ceilings, and floors.
1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- T. Install sleeve seals for piping penetrations of concrete walls and slabs.
1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors.
1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."



### 3.3 JOINT CONSTRUCTION

- A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.
- C. Hubless, Cast-Iron Soil Piping Coupled Joints:
  - 1. Join hubless, cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- D. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1.
  - 1. Cut threads full and clean using sharp dies.
  - 2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
    - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
    - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
    - c. Do not use pipe sections that have cracked or open welds.
- E. Grooved Joints: Cut groove ends of pipe in accordance with AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
- F. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- G. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:
  - 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
  - 2. ABS Piping: Join in accordance with ASTM D2235 and ASTM D2661 appendixes.
  - 3. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendixes.
- H. Joint Restraints and Sway Bracing:
  - 1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:
    - a. Provide axial restraint for pipe and fittings 5 inches (125 mm) and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
    - b. Provide rigid sway bracing for pipe and fittings 4 inches (100 mm) and larger, upstream and downstream of all changes in direction 45 degrees and greater.
    - c. Provide rigid sway bracing for pipe and fittings 5 inches (125 mm) and larger, upstream and downstream of all changes in direction and branch openings.

### 3.4 SPECIALTY PIPE FITTING INSTALLATION

#### A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Waste Drainage Piping: Unshielded, nonpressure transition couplings.

#### B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50)> and Smaller: Use dielectric nipples or unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100)>: Use dielectric flanges, flange kits, or nipples.
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

### 3.5 VALVE INSTALLATION

#### A. General valve installation requirements for general-duty valve installation are specified in the following Sections:

1. Section 220523.12 "Ball Valves for Plumbing Piping."
2. Section 220523.13 "Butterfly Valves for Plumbing Piping."
3. Section 220523.14 "Check Valves for Plumbing Piping."
4. Section 220523.15 "Gate Valves for Plumbing Piping."

#### B. Shutoff Valves:

1. Install shutoff valve on each sewage pump discharge.
2. Install full-port ball valve for piping NPS 2 (DN 50) and smaller.
3. Install gate valve for piping NPS 2-1/2 (DN 65) and larger.

#### C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

#### D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves.
2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Comply with requirements for backwater valve specified in Section 221319 "Sanitary Waste Piping Specialties."

### 3.6 INSTALLATION OF HANGERS AND SUPPORTS

#### A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

#### B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment".

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.

4. Install stainless steel pipe support clamps for vertical piping in corrosive environments.
  5. Vertical Piping: MSS Type 8 or Type 42 clamps.
  6. Install individual, straight, horizontal piping runs:
    - a. 100 Ft. (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    - b. Longer Than 100 Ft. (30 m): MSS Type 43, adjustable roller hangers.
    - c. Longer Than 100 Ft. (30 m) if Indicated: MSS Type 49, spring cushion rolls.
  7. Multiple, Straight, Horizontal Piping Runs 100 Ft. (30 m) or Longer: MSS Type 44 pipe rolls. Support pipe rolls on trapeze.
  8. Base of Vertical Piping: MSS Type 52 spring hangers.
- C. Install hangers for cast-iron soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Install hangers for ABS and PVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- E. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting, valve, and coupling.
- F. Support vertical runs of cast-iron soil piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- G. Support vertical runs of ABS and PVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

### 3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect waste and vent piping to the following:
  1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
  2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
  3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
  4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.

Pit installation option in first subparagraph below should be indicated on Drawings.

5. Install horizontal backwater valves with cleanout cover flush with floor.
6. Comply with requirements for backwater valves, cleanouts, and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
7. Equipment: Connect waste piping as indicated.

- a. Provide shutoff valve if indicated and union for each connection.
  - b. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. Make connections in accordance with the following unless otherwise indicated:
  - 1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
  - 2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

### 3.8 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.
- B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

### 3.9 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
  - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
  - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary waste and vent piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
  - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
    - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  - 2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
    - a. Expose work that was covered or concealed before it was tested.
  - 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

- a. Close openings in piping system and fill with water to point of overflow, but not less than 10 ft. head of water (30 kPa head of water).
  - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
  - c. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
    - a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1 inch wg (250 Pa).
    - b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
    - c. Air pressure must remain constant without introducing additional air throughout period of inspection.
    - d. Inspect plumbing fixture connections for gas and water leaks.
  5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
  6. Prepare reports for tests and required corrective action.

### 3.10 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.
- E. Repair damage to adjacent materials caused by waste and vent piping installation.

### 3.11 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller are to be any of the following:
  1. Service cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  2. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
  3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
  4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- C. Aboveground, soil and waste piping NPS 5 (DN 125) and larger are to be any of the following:
  1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
  3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- D. Aboveground, vent piping NPS 4 (DN 100) and smaller is to be any of the following:

1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  2. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
  3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
  4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- E. Aboveground, vent piping [NPS 5 (DN 125) and larger] <Insert pipe size range> is to be [ any of] the following:
1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
  3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- F. Underground, soil, waste, and vent piping NPS 4 (DN 100) and smaller are to be the following:
1. Extra-heavy cast-iron soil piping; gaskets; and gasketed joints.
  2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- G. Underground, soil and waste piping NPS 5 (DN 125) and larger are to be the following:
1. Extra-heavy, cast-iron soil piping; gaskets; and gasketed joints.
  2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION 22 13 16

## SECTION 22 13 19.13

### SANITARY DRAINS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section Includes:
  - 1. Floor drains.
  - 2. Floor sinks.
  - 3. Trench drains.

##### 1.4 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene styrene.
- B. FRP: Fiberglass-reinforced plastic.
- C. HDPE: High-density polyethylene.
- D. PE: Polyethylene.
- E. PP: Polypropylene.
- F. PVC: Polyvinyl chloride.

##### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.

## PART 2 - PRODUCTS

### 2.1 DRAIN ASSEMBLIES

- A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary piping specialty components.

### 2.2 FLOOR DRAINS

- A. Cast-Iron Floor Drains: – See floor plans for specifications
- B. Stainless-Steel Floor Drains, ASME A112.3.1: – See floor plans for specifications
- C. Stainless-Steel Floor Drains, ASME A112.6.3: – See floor plans for specifications

### 2.3 FLOOR SINKS - Kitchen– See floor plans for specifications

- A. Stainless-Steel Floor Sinks, ASME A112.6.7:

### 2.4 TRENCH DRAINS – Kitchen – See floor plans for specifications

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
  - 1. Position floor drains for easy access and maintenance.
  - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
  - 3. Set with grates depressed according to the following drainage area radii:
    - a. Radius, 30 Inches (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
    - b. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
    - c. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than 1-inch (25-mm) total depression.
  - 4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
    - a. Maintain integrity of waterproof membranes where penetrated.
  - 5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- B. Install trench drains at low points of surface areas to be drained.



1. Set grates of drains flush with finished surface, unless otherwise indicated.
- C. Comply with ASME A112.3.1 for installation of stainless-steel channel drainage systems.
1. Install on support devices, so that top will be flush with adjacent surface.
- D. Install FRP channel drainage system components on support devices, so that top will be flush with adjacent surface.
- E. Install plastic channel drainage system components on support devices, so that top will be flush with adjacent surface.
- F. Install open drain fittings with top of hub 1 inch (25 mm) above floor.

### 3.2 CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements in Section 221319 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.
- C. Comply with requirements in Section 221323 "Sanitary Waste Interceptors" for grease interceptors, grease-removal devices, oil interceptors, sand interceptors, and solid interceptors.
- D. Install piping adjacent to equipment to allow service and maintenance.
- E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.3 LABELING AND IDENTIFYING

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

### 3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19.13

## SECTION 22 13 19

### SANITARY WASTE PIPING SPECIALTIES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

###### A. Section Includes:

1. Backwater valves.
2. Cleanouts.
3. Air-admittance valves.
4. Miscellaneous sanitary drainage piping specialties.

###### B. Related Requirements:

1. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashing assemblies.
2. Section 077200 "Roof Accessories" for preformed flashings.
3. Section 078413 "Penetration Firestopping" for through-penetration firestop assemblies.
4. Section 221323 "Sanitary Waste Interceptors" for metal and concrete interceptors outside the building, grease interceptors, grease-removal devices, oil interceptors, and solids interceptors.
5. Section 221423 "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.

##### 1.4 DEFINITIONS

- A. ABS: Acrylonitrile butadiene styrene.
- B. PVC: Polyvinyl chloride.

##### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:

1. Show fabrication and installation details for frost-resistant vent terminals.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

## 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 ASSEMBLY DESCRIPTIONS

- A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

### 2.2 BACKWATER VALVES

- A. Horizontal, Cast-Iron Backwater Valves:
  1. Standard: ASME A112.14.1.
  2. Size: Same as connected piping.
  3. Body: Cast iron.
  4. Cover: Cast iron with bolted access check valve.
  5. End Connections: Hub and spigot.
  6. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang open for airflow unless subject to backflow condition.
  7. Extension: ASTM A74, Service Class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.
- B. Drain-Outlet Backwater Valves :
  1. Size: Same as floor drain outlet.
  2. Body: Cast iron or bronze; made for vertical installation in bottom outlet of floor drain.
  3. Check Valve: Removable ball float.
  4. Inlet: Threaded.
  5. Outlet: Threaded or spigot.

### 2.3 CLEANOUTS

- A. Cast-Iron Exposed Cleanouts:
  1. Standard: ASME A112.36.2M.
  2. Size: Same as connected drainage piping
  3. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
  4. Closure: Countersunk or raised-head plug.
  5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

- B. Cast-Iron Exposed Floor Cleanouts:
1. Standard: ASME A112.36.2M for adjustable housing or cast-iron soil pipe with cast-iron ferrule cleanout.
  2. Size: Same as connected branch.
  3. Type: Adjustable housing or Cast-iron soil pipe with cast-iron ferrule.
  4. Body or Ferrule: Cast iron.
  5. Clamping Device: Required.
  6. Outlet Connection: Spigot.
  7. Closure: Brass plug with straight threads and gasket.
  8. Adjustable Housing Material: Cast iron with threads.
  9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
  10. Frame and Cover Shape: Round.
  11. Top-Loading Classification: Heavy or Medium Duty.
  12. Riser: ASTM A74, Service Class, cast-iron drainage pipe fitting and riser to cleanout.
- C. Cast-Iron Wall Cleanouts:
1. Standard: ASME A112.36.2M. Include wall access.
  2. Size: Same as connected drainage piping.
  3. Body: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
  4. Closure Plug:
    - a. Cast iron.
    - b. Countersunk or raised head.
    - c. Drilled and threaded for cover attachment screw.
    - d. Size: Same as or not more than one size smaller than cleanout size.
  5. Wall Access, Cover Plate: Round, flat, chrome-plated brass or stainless steel cover plate with screw.
  6. Wall Access, Frame and Cover: Round nickel-bronze, copper-alloy, or stainless steel wall-installation frame and cover.

## 2.4 AIR-ADMITTANCE VALVES

- A. Fixture Air-Admittance Valves:
1. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
  2. Housing: Plastic.
  3. Operation: Mechanical sealing diaphragm.
  4. Size: Same as connected fixture or branch vent piping.
- B. Stack Air-Admittance Valves:
1. Standard: ASSE 1050 for vent stacks.
  2. Housing: Plastic.
  3. Operation: Mechanical sealing diaphragm.
  4. Size: Same as connected stack vent or vent stack.
- C. Wall Box for Air-Admittance Valves :
1. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.
  2. Size: Approximately 6 inches wide by 6 inches high by 4 inches deep (150 mm wide by 150 mm high by 100 mm deep).

## 2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

### A. Open Drains:

1. Description: Shop or field fabricate from ASTM A74, Service Class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C564 rubber gaskets.
2. Size: Same as connected waste piping.

### B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
  - a. NPS 2 (DN 50): 4-inch- (100-mm-) minimum water seal.
  - b. NPS 2-1/2 (DN 65) and Larger: 5-inch- (125-mm-) minimum water seal.

### C. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 (DN 15) side inlet.

### D. Floor-Drain, Inline Trap Seal:

1. Description: Inline floor drain trap seal, forming a physical barrier to slow trap evaporation while not impeding flow from drain.
2. Material: Polymer.
3. Standard: Tested and certified in accordance with ASSE 1072.
4. Listing: ICC-ES or IAPMO listed.
5. Size: Same as floor drain outlet or strainer throat.

### E. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

### F. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch (25 mm) above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

### G. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

- H. Vent Caps:
  - 1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
  - 2. Size: Same as connected stack vent or vent stack.
- I. Frost-Resistant Vent Terminals:
  - 1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
  - 2. Design: To provide 1-inch (25-mm) enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.
- J. Expansion Joints:
  - 1. Standard: ASME A112.6.4.
  - 2. Body: Cast iron with bronze sleeve, packing, and gland.
  - 3. End Connections: Matching connected piping.
  - 4. Size: Same as connected soil, waste, or vent piping.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install backwater valves in building drain piping.
  - 1. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
  - 1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
  - 2. Locate at each change in direction of piping greater than 45 degrees.
  - 3. Locate at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
  - 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install fixture air-admittance valves on fixture drain piping.
- F. Install stack air-admittance valves at top of stack vent and vent stack piping.
- G. Install air-admittance-valve wall boxes recessed in wall.
- H. Assemble open drain fittings and install with top of hub 1 inch (25 mm) above floor.

- I. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- J. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
  - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
  - 2. Size: Same as floor drain inlet.
- K. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- L. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.
- M. Install vent caps on each vent pipe passing through roof.
- N. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.
- O. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- P. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.
- Q. Install wood-blocking reinforcement for wall-mounting-type specialties.
- R. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

### 3.2 PIPING CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment, to allow service and maintenance.

### 3.3 LABELING AND IDENTIFYING

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.
  - 1. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

### 3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19



## SECTION 22 13 23

### SANITARY WASTE INTERCEPTORS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section Includes:
  - 1. Grease interceptors.
  - 2. Sand interceptors.

##### 1.4 DEFINITIONS

- A. FRP: Fiberglass-reinforced plastic.
- B. PP: Polypropylene.

##### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of metal and plastic interceptor. Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.
- B. Shop Drawings: For each type and size of precast-concrete interceptor indicated.
  - 1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.

##### 1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Piping connections. Include size, location, and elevation of each.

2. Interface with underground structures and utility services.

## 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sanitary waste interceptors to include in emergency, operation, and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 GREASE INTERCEPTORS

- A. Plastic Grease Interceptors:
  1. Standard: IAPMO/ANSI Z1001-2007, ASTM C-581, for intercepting and retaining FOG from food-preparation or -processing wastewater.
  2. Body Material: Fiberglass Reinforced Plastic. Polyester resin and E glass
  3. Min Thickness: ¼" wall and 3/8" top and bottom bowls.
  4. Body Dimensions: Oval - 96Hx132Dx62W Inches.
  5. Body Extension: Required to reach grade.
  6. Manway Covers: H20 Traffic Loading
  7. Dry Weight of Tank: 1480 lbs
  8. Capacities and Characteristics:
    - a. Liquid Capacity: 1,300 US Gal.
    - b. Number of Accessways: Two.
    - c. Number of Vent Ports: Two.
    - d. Number of Inspection Ports: Two
    - e. Inlet and Outlet Pipe Size: NPS 4 (DN 100).
    - f. End Connections: Threaded.
    - g. Cleanout: field installed on outlet.
    - h. Trapped Outlet Required: No.
    - i. Vent Pipe: Qty 2, Size NPS 3 (DN 75).
    - j. Mounting: Buried.
    - k. Flow-Control Fitting: Not required.
    - l. Operation: Manual cleaning.

### 2.2 SAND INTERCEPTORS

- A. Description: Factory-fabricated, cast-iron or steel body and inlet grate; with settlement chamber and removable basket or strainer.
- B. Outlet Piping Connection: Hub, hubless, or threaded, unless otherwise indicated.
- C. Grate: Cast iron or steel with reinforcement to provide ASTM C890, heavy duty load.
- D. Capacities and Characteristics:
  1. Capacity: 360 gal. (1363 L).
  2. Overall Dimensions: 48x36 inches (1219x965 mm)
  3. Outlet Pipe Size: NPS 4 (DN 100)>.
  4. Trapped Outlet Required: No.
  5. Vent Pipe Size: Not required.

6. Installation Position: Top flush with grade, provide extension assembly based on invert elevation of incoming piping.

### PART 3 - EXECUTION

#### 3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

#### 3.2 INSTALLATION

- A. Equipment Mounting:

1. Install grease interceptor on cast-in-place concrete anti-buoyancy slab for high water table conditions per manufacturer recommendations.
2. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

- B. Set interceptors level and plumb.

- C. Install manhole risers from top of underground concrete interceptors to manholes and gratings at finished grade.

- D. Set tops of manhole frames and covers flush with finished surface in pavements.

1. Set tops 3 inches (75 mm) above finish surface elsewhere unless otherwise indicated.

- E. Set tops of grating frames and grates flush with finished surface.

- F. Set plastic interceptors level and plumb.

- G. Set tops of metal interceptor covers flush with finished surface in pavements.

1. Set tops 3 inches (75 mm) above finish surface elsewhere unless otherwise indicated.

- H. Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.

1. Above-Floor Installation: Set unit with bottom resting on floor unless otherwise indicated.
2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
4. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.

- I. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet.

1. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.

### 3.3 PIPING CONNECTIONS

- A. Piping installation requirements are specified in Section 221316 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Make piping connections between interceptors and piping systems.

### 3.4 IDENTIFICATION

- A. Identification materials and installation are specified in Section 312000 "Earth Moving."
  - 1. Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.
  - 2. Use warning tapes or detectable warning tape over ferrous piping.
  - 3. Use detectable warning tape over nonferrous piping and over edges of underground structures.
- B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
  - 1. Grease interceptors.
  - 2. Sand interceptors.

### 3.5 PROTECTION

- A. Protect sanitary waste interceptors from damage during construction period.
- B. Repair damage to adjacent materials caused by sanitary waste interceptor installation.

END OF SECTION 22 13 23

SECTION 22 14 13

FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Section Includes:

- 1. Hub-and-spigot, cast-iron soil pipe and fittings.
- 2. Hubless, cast-iron soil pipe and fittings.
- 3. ABS pipe and fittings.
- 4. PVC pipe and fittings.
- 5. Specialty pipe and fittings.

B. Related Requirements:

- 1. Section 221429 "Sump Pumps" for storm drainage pumps.
- 2. Section 334400 "Stormwater Utility Equipment" for storm drainage piping outside the building.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Detail storm drainage piping. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

- 1. Structural members to which drainage piping will be attached or suspended from.

- B. Field quality-control reports.

## 1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
  - 1. Storm Drainage Piping: 10-foot head of water (30 kPa).

### 2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings:
  - 1. Marked with CISPI collective trademark and NSF certification mark.
  - 2. Class: ASTM A 74, Service and Extra Heavy classes.
- B. Gaskets: ASTM C 564, rubber.
- C. Caulking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

### 2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings:
  - 1. Marked with CISPI collective trademark and NSF certification mark.
  - 2. Standard: ASTM A 888 or CISPI 301.
- B. CISPI, Hubless-Piping Couplings:
  - 1. Couplings shall bear CISPI collective trademark and NSF certification mark.
  - 2. Standards: ASTM C 1277 and CISPI 310.
  - 3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
- C. Heavy-Duty, Hubless-Piping Couplings:
  - 1. Standard: ASTM C 1540.
  - 2. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
- D. Cast-Iron, Hubless-Piping Couplings:
  - 1. Standard: ASTM C 1277.
  - 2. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

## 2.4 ABS PIPE AND FITTINGS

- A. NSF Marking: Comply with NSF 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.
- B. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.
- C. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.
- D. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.
- E. Solvent Cement: ASTM D 2235.

## 2.5 PVC PIPE AND FITTINGS

- A. NSF Marking: Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.
- B. Solid-Wall PVC Pipe: ASTM D 2665; drain, waste, and vent.
- C. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
- D. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- E. Adhesive Primer: ASTM F 656.
- F. Solvent Cement: ASTM D 2564.

## 2.6 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
  - 1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections same size as and compatible with pipes to be joined.
  - 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
  - 3. Unshielded, Nonpressure Transition Couplings:
    - a. Standard: ASTM C 1173.
    - b. Description: Elastomeric sleeve, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
    - c. Sleeve Materials:
      - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
      - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
      - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
  - 4. Shielded, Nonpressure Transition Couplings:

- a. Standard: ASTM C 1460.
  - b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
  - c. End Connections: Same size as and compatible with pipes to be joined.
5. Pressure Transition Couplings:
- a. Standard: AWWA C219.
  - b. Description: Metal, sleeve-type couplings same size as pipes to be joined, and with pressure rating at least equal to and ends compatible with pipes to be joined.
  - c. Center-Sleeve Material: Manufacturer's standard.
  - d. Gasket Material: Natural or synthetic rubber.
  - e. Metal Component Finish: Corrosion-resistant coating or material.
- B. Dielectric Fittings:
- 1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
  - 2. Dielectric Unions:
    - a. Description:
      - 1) Standard: ASSE 1079.
      - 2) Pressure Rating: 150 psig (1035 kPa) minimum at 180 deg F (82 deg C).
      - 3) End Connections: Solder-joint copper alloy and threaded ferrous.
  - 3. Dielectric Flanges:
    - a. Description:
      - 1) Standard: ASSE 1079.
      - 2) Factory-fabricated, bolted, companion-flange assembly.
      - 3) Pressure Rating: 150 psig (1035 kPa) minimum at 180 deg F (82 deg C)
      - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
  - 4. Dielectric-Flange Insulating Kits:
    - a. Description:
      - 1) Nonconducting materials for field assembly of companion flanges.
      - 2) Pressure Rating: 150 psig (1035 kPa).
      - 3) Gasket: Neoprene or phenolic.
      - 4) Bolt Sleeves: Phenolic or polyethylene.
      - 5) Washers: Phenolic with steel-backing washers.
  - 5. Dielectric Nipples:
    - a. Description: Electroplated steel nipple.
    - b. Standard: IAPMO PS 66.
    - c. Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
    - d. End Connections: Male threaded or grooved.
    - e. Lining: Inert and noncorrosive, propylene.



## PART 3 - EXECUTION

### 3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

### 3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
  - 1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
  - 2. Install piping as indicated unless deviations from layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- K. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.
  - 1. Do not change direction of flow more than 90 degrees.
  - 2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
    - a. Reducing size of drainage piping in direction of flow is prohibited.
- L. Lay buried building piping beginning at low point of each system.
  - 1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.

2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
  3. Maintain swab in piping and pull past each joint as completed.
- M. Install piping at the following minimum slopes unless otherwise indicated:
1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
  2. Horizontal Storm Drainage Piping: 2 percent downward in direction of flow.
- N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- O. Install aboveground ABS piping according to ASTM D 2661.
- P. Install aboveground PVC piping according to ASTM D 2665.
- Q. Install underground ABS and PVC piping according to ASTM D 2321.
- R. Plumbing Specialties:
1. Install backwater valves in storm drainage gravity-flow piping.
    - a. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."
  2. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping.
    - a. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."
  3. Install drains in storm drainage gravity-flow piping.
    - a. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."
- S. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- T. Install sleeves for piping penetrations of walls, ceilings, and floors.
1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- U. Install sleeve seals for piping penetrations of concrete walls and slabs.
1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- V. Install escutcheons for piping penetrations of walls, ceilings, and floors.
1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

### 3.3 JOINT CONSTRUCTION

- A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.
- C. Hubless, Cast-Iron Soil Piping Coupled Joints:
  - 1. Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.
  - 1. Cut threads full and clean using sharp dies.
  - 2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
    - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
    - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
    - c. Do not use pipe sections that have cracked or open welds.
- E. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
- F. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- G. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendices.
  - 3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendices.
- H. Joint Restraints and Sway Bracing:
  - 1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:
    - a. Provide axial restraint for pipe and fittings 5 inches (125 mm) and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
    - b. Provide rigid sway bracing for pipe and fittings 4 inches (100 mm) and larger, upstream and downstream of all changes in direction 45 degrees and greater.
    - c. Provide rigid sway bracing for pipe and fittings 5 inches (125 mm) and larger, upstream and downstream of all changes in direction and branch openings.

### 3.4 SPECIALTY PIPE FITTING INSTALLATION

#### A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Drainage Piping: Unshielded, nonpressure transition couplings.
3. In Aboveground Force-Main Piping: Fitting-type transition couplings.
4. In Underground Force-Main Piping:
  - a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
  - b. NPS 2 (DN 50) and Larger: Pressure transition couplings.

#### B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric nipples.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.
4. Dielectric Fittings for [NPS 5 (DN 125) and Larger: Use dielectric flange kits.

### 3.5 VALVE INSTALLATION

#### A. General valve installation requirements for general-duty valve installations are specified in the following Sections:

1. Section 220523.12 "Ball Valves for Plumbing Piping."
2. Section 220523.13 "Butterfly Valves for Plumbing Piping."
3. Section 220523.14 "Check Valves for Plumbing Piping."
4. Section 220523.15 "Gate Valves for Plumbing Piping."

#### B. Shutoff Valves:

1. Install shutoff valve on each sump pump discharge.
2. Install full port ball valve for piping NS 2 (DN 50) and smaller.
3. Install gate valve for piping NPS 2-1/2 (DN 65) and larger.

#### C. Check Valves: Install swing-check valve, between pump and shutoff valve, on each sump pump discharge.

#### D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves.
2. Install backwater valves in accessible locations.
3. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."

### 3.6 INSTALLATION OF HANGERS AND SUPPORTS

#### A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

#### B. Comply with requirements for hangers, supports, and anchor devices specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
  2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
  3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
  4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
  5. Vertical Piping: MSS Type 8 or Type 42, clamps.
  6. Install individual, straight, horizontal piping runs:
    - a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    - b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
    - c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.
  7. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
  8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install hangers for cast-iron soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Install hangers for ABS and PVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- E. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting, valve, and coupling.
- F. Support vertical cast-iron piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent, but as a minimum at base and at each floor.
- G. Support vertical ABS and PVC piping with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

### 3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
  1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
  2. Install horizontal backwater valves with cleanout cover flush with floor.
  3. Comply with requirements for backwater valves, cleanouts, and drains specified in Section 221423 "Storm Drainage Piping Specialties."
- D. Where installing piping adjacent to equipment, allow space for service and maintenance.
- E. Make connections according to the following unless otherwise indicated:
  1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

### 3.8 IDENTIFICATION

- A. Identify exposed storm drainage piping.
- B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

### 3.9 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
  1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
  2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
  1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
    - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved.
    - a. Expose work that was covered or concealed before it was tested.
  3. Test Procedure:
    - a. Test storm drainage pipin[, except outside leaders, on completion of roughing-in.
    - b. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
  4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
  5. Prepare reports for tests and required corrective action.
- C. Piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.10 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.

- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

### 3.11 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground storm drainage piping NPS 6 (DN 150) and smaller shall be any of the following:
  - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  - 2. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, hubless-piping couplings; and coupled joints.
  - 3. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
  - 4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
  - 5. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- C. Aboveground, storm drainage piping NPS 8 (DN 200) and larger shall be any of the following:
  - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  - 2. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, hubless-piping couplings; and coupled joints.
  - 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
  - 4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- D. Underground storm drainage piping NPS 6 (DN 150) and smaller shall be any of the following:
  - 1. Extra Heavy class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  - 2. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, cast-iron, hubless-piping couplings; and coupled joints.
- E. Underground, storm drainage piping NPS 8 (DN 200) and larger shall be any of the following:
  - 1. Extra Heavy class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  - 2. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, cast-iron, hubless-piping couplings; and coupled joints.

END OF SECTION 22 14 13

## SECTION 22 14 23

### STORM DRAINAGE PIPING SPECIALTIES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

###### A. Section Includes:

1. Metal roof drains.
2. Miscellaneous storm drainage piping specialties.
3. Cleanouts.
4. Backwater valves.

###### B. Related Requirements:

1. Section 076200 "Sheet Metal Flashing and Trim" for penetrations of roofs.
2. Section 078413 "Penetration Firestopping" for firestopping roof penetrations.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

##### 1.5 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

#### PART 2 - PRODUCTS

##### 2.1 METAL ROOF DRAINS

- A. Cast-Iron, Combination Roof and Overflow Drains:
  1. Standard: ASME A112.6.4.



2. Body Material: Cast iron.
3. Dimension of Body: Nominal: 18 x 10 inch (4 x 254-mm).
4. Combination Flashing Ring and Gravel Stop: Required.
5. Outlet: Bottom.
6. Outlet Type: No hub.
7. Underdeck Clamp: Required.
8. Sump Receiver Plate: Required.
9. Dome Material: Cast iron.
10. Vandal-Proof Dome: Not required.

## 2.2 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

### A. Downspout Adapters:

1. Description: Manufactured, gray-iron casting, for attaching to horizontal-outlet, parapet roof drain and to exterior sheet metal downspout.
2. Size: Inlet size to match parapet drain outlet.

### B. Downspout Boots:

1. Description: Manufactured, ASTM A48/A48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 (DN 100) outlet; and shop-applied bituminous coating.
2. Size: Inlet size to match downspout and NPS 4 (DN 100) outlet.

### C. Metal Downspout Nozzles:

1. Description: Nozzle with wall flange and mounting holes to cover rough opening and serve as anchor..
2. Size: Same as connected downspout.
3. Material: Cast bronze or nickel bronze nozzle and flange.
4. Piping Connection Type: No-hub.

## 2.3 CLEANOUTS

### A. Cast-Iron Exposed Cleanouts:

1. Standard: ASME A112.36.2M.
2. Size: Same as connected branch.
3. Body Material: No-hub, cast-iron soil pipe test tee as required to match connected piping.
4. Closure: Countersunk plug.
5. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.

### B. Cast-Iron Exposed Floor Cleanouts:

1. Standard: ASME A112.36.2M.
2. Size: Same as connected branch.
3. Type: Adjustable housing.
4. Body or Ferrule: Cast iron.
5. Clamping Device: Not required.
6. Outlet Connection: No hub.
7. Closure: Brass plug with straight threads and gasket.
8. Adjustable Housing Material: Cast iron with threads.
9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
10. Frame and Cover Shape: Round.
11. Top Loading Classification: Extra-Heavy Duty.
12. Riser: ASTM A74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

- C. Plastic Floor Cleanouts:
  1. Size: Same as connected branch.
  2. Body Material: PVC.
  3. Closure Plug: PVC.
  4. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.
  
- D. Cast-Iron Wall Cleanouts:
  1. Standard: ASME A112.36.2M. Include wall access.
  2. Size: Same as connected drainage piping.
  3. Body: No-hub, cast-iron soil pipe test tee as required to match connected piping.
  4. Closure Plug:
    - a. Brass.
    - b. Countersunk head.
    - c. Drilled and threaded for cover attachment screw.
    - d. Size: Same as, or not more than, one size smaller than cleanout size.
  5. Wall Access, Cover Plate: Round, deep, chrome-plated bronze cover plate with screw.
  6. Wall Access, Frame and Cover: Round, nickel-bronze, copper-alloy, or stainless steel wall-installation frame and cover.
  
- E. Test Tees:
  1. Standard: ASME A112.36.2M and ASTM A74, ASTM A888, or CISPI 301.
  2. Size: Same as connected drainage piping.
  3. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or no-hub, cast-iron soil-pipe test tee as required to match connected piping.
  4. Closure Plug: Countersunk.
  5. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.

## 2.4 BACKWATER VALVES

- A. Cast-Iron, Horizontal Backwater Valves:
  1. Standard: ASME A112.14.1.
  2. Size: Same as connected piping.
  3. Body Material: Cast iron.
  4. Cover: Cast iron with bolted access check valve.
  5. End Connections: no hub.
  6. Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
  7. Extension: ASTM A74, Service class; full-size, cast-iron soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.
  
- B. Cast-Iron, Drain-Outlet Backwater Valves:
  1. Standard: ASME A112.14.1.
  2. Size: Same as floor drain outlet.
  3. Body Material: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
  4. Check Valve: Removable ball float.
  5. Inlet: Threaded.
  6. Outlet: Threaded or spigot.
  
- C. Plastic, Horizontal Backwater Valves:
  1. Standard: ASME A112.14.1.
  2. Size: Same as connected piping.

3. Body Material: ABS.
4. Cover: Same material as body with threaded access to check valve.
5. Check Valve: Removable swing check.
6. End Connections: Socket type.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install roof drains at low points of roof areas in accordance with roof membrane manufacturer's written installation instructions.
  1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
  2. Install expansion joints, if indicated, in roof drain outlets.
  3. Position roof drains for easy access and maintenance.
- B. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.
- C. Install downspout boots at grade with top 6 inches (152 mm) above grade. Secure to building wall.
- D. Install downspout nozzles at exposed bottom of conductors where they spill onto grade.
- E. Install cleanouts in aboveground piping and building drain piping in accordance with the following instructions unless otherwise indicated:
  1. Use cleanouts the same size as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
  2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
  3. Locate cleanouts at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
  4. Locate cleanouts at base of each vertical storm piping conductor.
- F. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- G. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- H. Install horizontal backwater valves in floor with cover flush with floor.
- I. Install drain-outlet backwater valves in outlet of drains.
- J. Install test tees in vertical conductors and near floor.
- K. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.
- L. Install through-penetration firestop assemblies for penetrations of fire- and smoke-rated assemblies.
  1. Comply with requirements in Section 078413 "Penetration Firestopping."

### 3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

### 3.3 INSTALLATION OF FLASHING

- A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.

### 3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 14 23

## SECTION 22 14 29

### SUMP PUMPS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

###### A. Section Includes:

1. Submersible sump pumps.
2. Sump-pump basins and basin covers.

###### B. Related Requirements:

1. Section 221329 "Sanitary Sewerage Pumps" for effluent and sewage pumps.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

###### B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
4. Include diagrams for power, signal, and control wiring.

##### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with manufacturer's written instructions for handling.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

### 2.2 SUBMERSIBLE SUMP PUMPS

- A. Submersible, Fixed-Position, Single-Seal Sump Pumps:
  - 1. Description: Factory-assembled and -tested sump-pump unit.
  - 2. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
  - 3. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
  - 4. Impeller: Statically and dynamically balanced, ASTM A48/A48M, Class No. 25 A cast iron design for clear wastewater handling, and keyed and secured to shaft.
  - 5. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
  - 6. Seal: Mechanical.
  - 7. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
  - 8. Controls:
    - a. Enclosure: NEMA 250, Type 4X.
    - b. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    - c. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
    - d. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
    - e. Provide oil-sensing controls for elevator sump pumps. Installation shall comply with ASME A17.1.
  - 9. Control-Interface Features:
    - a. Remote Alarm Contacts: For remote alarm interface.
    - b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

- 1) On-off status of pump.
- 2) Alarm status.

## 2.3 SUMP-PUMP BASINS AND BASIN COVERS

- A. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.
  1. Material: Cast iron or Fiberglass.
  2. Reinforcement: Mounting plates for pumps, fittings, and accessories.
  3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.
- B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
  1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.
- C. Capacities and Characteristics: See schedule on drawings.

## 2.4 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."
  1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- B. Motors for submersible pumps shall be hermetically sealed.

## PART 3 - EXECUTION

### 3.1 EARTHWORK

- A. Excavation and filling are specified in Section 312000 "Earth Moving."

### 3.2 EXAMINATION

- A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

### 3.3 INSTALLATION

- A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.

### 3.4 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance.

### 3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test, inspect, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections:
  - 1. Perform each visual and mechanical inspection.
  - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Pumps and controls will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.

### 3.7 ADJUSTING

- A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust control set points.

### 3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION 22 14 29



SECTION 22 32 00

DOMESTIC WATER FILTRATION EQUIPMENT

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

- A. Section Includes:

- 1. Automatic Self Cleaning filters.

- B. Related Sections:

- 1. Section 221119 "Domestic Water Piping Specialties" for plumbing piping strainers.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Filters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

- 1. The term "withstand" means that "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for filters and separators. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

- B. Shop Drawings: For water filtration equipment. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For filters, accessories, and components, from manufacturer.
  1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Certificates of Shop Inspections and Data Reports: For products required to have ASME label, signed by product manufacturer.
- C. Welding certificates.
- D. Source quality-control reports.
- E. Field quality-control reports.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For water filtration equipment to include in emergency, operation, and maintenance manuals.

#### 1.8 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of water filtration equipment through one source from a single manufacturer.
- B. Welding Qualifications: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NSF 61 Annex, "Drinking Water System Components - Health Effects," for all components that will be in contact with potable water.

#### 1.9 COORDINATION

- A. Coordinate size and location of concrete bases with actual equipment provided.

## PART 2 - PRODUCTS

### 2.1 AUTOMATIC SELF CLEANING FILTERS

#### A. Automatic Filters:

1. Description: Factory-fabricated and -tested, self-cleaning screen type water filter, two stage cleaning screens, flushing valve, and an electronic controller for removing sediment particles from water.
  - a. Filter Body: Corrosion resistant with distribution system and media.
    - 1) Construction: AISI 304 stainless steel, NSF-61.
      - a) Fabricate and label steel filter tanks to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
      - b) Fabricate supports, base, and attachments to tank with reinforcement strong enough to resist filter movement during a seismic event when filter base is anchored to building structure.
    - 2) Steel Tank Pipe Connections NPS 2-1/2 (DN 65) and Larger: Steel, Class 150 flanges according to ASME B16.5 or grooved according to AWWA C606.
  - b. Internal and Wetted Parts: AISI 316L stainless steel
  - c. Screen: sintered AISI 316L stainless steel screen, 10 micron.
  - d. Piping: ASTM B88, Type L (ASTM B88M, Type B) copper water tube, copper-alloy solder-joint fittings, and flanged joints.
  - e. Controls: Automatic for control of filter backwash assembly; factory wired for single, external electrical connection.
    - 1) Panel: NEMA Type 3 enclosure.
    - 2) Backwash: Manual, Timer, and Automatic; with differential-pressure-switch initiation device.
    - 3) Backwash Valve: Integral 2" 316L stainless steel flushing ball valve.
    - 4) Emergency alarm for BAS monitoring
  - f. Support: Pad mounted on field fabricate steel frame.
2. Capacity and Characteristics: See schedule on drawings.

### 2.2 SOURCE QUALITY CONTROL

- A. Before shipping, hydrostatically test filters to minimum of one and one-half times pressure rating.
- B. Prepare test reports.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of filters.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before equipment installation.
- C. Examine walls and floors for suitable conditions where filters will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 EQUIPMENT MOUNTING

- A. Equipment Mounting: Install filter frames/stands on concrete bases. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."
  - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of concrete base.
  - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.

### 3.3 AUTOMATIC FILTER INSTALLATION

- A. Install filters on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
- B. Prepare filter tank frame and distribution piping.
- C. Prepare backwash piping and extend to nearest floor drain.
- D. Ensure adequate clearances for maintenance.
- E. Install seismic restraints for filter tanks and accessories and anchor to building structure.

### 3.4 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Make piping connections between water filtration equipment and dissimilar-metal water piping with dielectric fittings. Comply with requirements for dielectric fittings specified in Section 221116 "Domestic Water Piping."

- D. Install shutoff valves on inlet and outlet piping of each water filter.
  - 1. Comply with requirements for metal general-duty valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."
  - 2. Comply with requirements for plastic valves specified in Section 221116 "Domestic Water Piping."
  - 3. Exception: Water filtration equipment with factory-installed shutoff valves at locations indicated.
- E. Install pressure gages on inlet and outlet piping of each water filter. Comply with requirements for pressure gages specified in Section 220519 "Meters and Gages for Plumbing Piping."
  - 1. Exception: Water filtration equipment with factory-installed pressure gages at locations indicated.
- F. Install valved bypass water piping around each water filter.
  - 1. Comply with requirements for metal general-duty valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," Section 220523.14 "Check Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."
  - 2. Comply with requirements for plastic valves specified in Section 221116 "Domestic Water Piping."
  - 3. Comply with requirements for water piping specified in Section 221116 "Domestic Water Piping."
- G. Install drains as indirect wastes to spill into open drains or over floor drains.

### 3.5 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

### 3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- D. Domestic water filtration equipment will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

### 3.7 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service for filters.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
- B. Sample filter filtrate after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics.

### 3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain filters.

END OF SECTION 22 32 00

## SECTION 22 34 00

### FUEL-FIRED, DOMESTIC-WATER HEATERS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section Includes:
  - 1. Gas-fired, tankless, domestic-water heaters.
  - 2. Domestic-water heater accessories.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
  - 1. Include diagrams for power, signal, and control wiring.

##### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Equipment room drawing or BIM model, drawn to scale, on which the items described in this Section are shown and coordinated with all building trades.
- B. Seismic Qualification Data: Certificates, for fuel-fired, domestic-water heaters, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Product Certificates: For each type of gas-fired, tankless domestic-water heater.

- D. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- E. Source quality-control reports.
- F. Field quality-control reports.
- G. Sample Warranty: For special warranty.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.

#### 1.7 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

#### 1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including storage tank and supports.
    - b. Faulty operation of controls.
    - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
  - 2. Warranty Periods: From date of Substantial Completion.
    - a. Gas-Fired, Tankless, Domestic-Water Heaters:
      - 1) Heat Exchanger: Ten years.
      - 2) Controls and Other Components: Two years.
    - b. Expansion Tanks: Five years.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.



1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  2. Component Importance Factor: 1.5.
- C. ASHRAE/IES Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IES 90.1.
- D. ASME Compliance:
1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
  2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.
- E. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.
- 2.2 GAS-FIRED, TANKLESS, DOMESTIC-WATER HEATERS
- A. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
- B. Standard: ANSI Z21.10.3/CSA 4.3 for gas-fired, instantaneous, domestic-water heaters for indoor application.
- C. Description: Water heater shall be direct fired, fully condensing, water-tube design. Power burner shall have full modulation. The minimum firing rate shall not exceed 30,000 BTU/HR input. Water heaters that have an input greater than 30,000 BTU/hr at minimum fire will not be considered equal. The water heater shall have the capability of discharging into a positive pressure vent. Water heater thermal efficiency shall increase with decreasing load (output), while maintaining set point. Water heater shall have an operational set point capability of 100 °F to 190 °F and shall maintain the outlet temperature within an accuracy of +/- 4 °F during load changes of up to 30% rated capacity. Water heater shall be factory-fabricated, factory-assembled and factory-tested, water-tube condensing water heater with heat exchanger sealed pressure-tight, built on a steel base, including a sealed insulated sheet metal enclosure that acts as combustion-air intake plenum with a built in serviceable air filter.
- D. Heat Exchanger: The heat exchanger shall be constructed with 316L stainless steel helical water tube, fully floating with no welded joints in the exchanger. The exchanger will have a single-pass unitary design (no separate primary and secondary heat exchanger). The water tubes shall be 0.75" ID, with no less than 0.0472" wall thickness. The heat exchanger shall be ASME Sect IV (HLW) stamped for a working pressure not less than 160 psig.
- E. Modulating Fuel/Air Valve and Burner: The water heater burner shall be capable of a 16.6-to-1, turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves. The burner shall be stainless fiber mesh covering a stainless steel body with spark ignition and flame rectification. All burner material exposed to the combustion zone shall be of stainless steel construction. There shall be no moving parts within the burner itself. A modulating air/fuel valve shall meter the air and fuel input. A variable frequency drive (VFD), controlled pre-mix blower shall be used to ensure the optimum mixing of air and fuel between the air/fuel valve and the burner.

- F. Exhaust Manifold: Polypropylene with a NPS 4 (100 DN) diameter. Consult manufacturer for header sizing when combining more than one unit.
- G. Ignition: Ignition shall be via spark ignition with 100 percent main-valve shutoff and dual electronic flame supervision.
- H. Controls: Water heater control system shall be masterless cascading design with no master/slave designation. The entire system shall have built-in usage optimization routines.
  - 1. Control Panel: Shall consist of one individual circuit. Circuit board to include touch display and a CPU board housing all control functions. Each board shall be individually replaceable.
  - 2. The combustion safeguard/flame monitoring system shall use spark ignition and a rectification-type flame sensor.
  - 3. The unit shall have a selectable exhaust temperature limit suitable for venting with PVC or CPVC/Polypropylene/Stainless Steel (AL29-4C).
  - 4. The controls shall annunciate water heater and sensor status and include extensive self-diagnostic capabilities.
    - a. Set point High Limit: Set point high limit allows for a selectable maximum water heater outlet temperature and acts as temperature limiting governor. Setpoint limit is based on a closed loop function that automatically limits firing rate to maintain outlet temperature
  - 5. The water heater control system shall incorporate the following additional features for enhanced external system interface:
    - a. Temperature set point
    - b. High exhaust temperature monitoring and control. Turn down the gas valve until the exhaust temperature is kept below selected material (PVC or CPVC)
    - c. Cascading via RS232
    - d. Error Code Display / Error Code History
    - e. Monitor and Access to daily, weekly, monthly water usage data
    - f. Monitor inlet/outlet temperatures, flow rates, flue gas temperatures, combustion rates via onboard touchscreen and via app.
  - 6. Water Heater Management: the water heater control system shall incorporate onboard multi-unit sequencing logic that would allow Masterless Cascading (Not Lead/Lag) functionality & sequencing between multiple water heaters operating in parallel and must have the following capabilities:
    - a. Efficiently sequence 2 up to 8 (~2,000,000 Btu) heat exchangers on the same system to meet the load requirement.
    - b. Individual heat exchanger logic to enable accurate temperature control.
    - c. Operate one motorized valve per heat exchanger as an element of the load sequencing, Valves shall close with decreased load as heaters turn off, minimum of one (depending upon Mode selection) must always stay open for recirculation.
    - d. Automatically rotate Start/Stop amongst the heat exchangers in the chain based upon an internal calculation of run hours, water through put, burner starts and stops and length of time each burner has been firing. Sequencing is not based upon next in line (Lead/Lag), it is based upon the most logical (least used) heat exchanger in an effort to equalize unit run hours.
    - e. Automatic bump-less transfer of sequencing in case of heat exchanger failure. All systems must be able to fail all but one heat exchanger in any order or for any reason and the last will continue to operate.
    - f. Each heat exchanger will default to individual control upon failure of the sequencing chain.

- g. Automatic isolation of heat exchanger module from water circuit in case of failure and prevention of cold water from exiting the system
  - h. Masterless control, change any parameter in any one of the units and all the rest in the series will automatically adjust to the most recent parameter change.
7. Electrical Power:
- a. Single Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers and other electrical devices shall provide a single-point field power connection to the water heater.
  - b. Electrical characteristics: 120 V, single phase, 60 Hz.
  - c. Full load amp current: 5 amps or less per 200,000 BTU of heat input.
8. Condensate:
- a. Condensate traps manufactured from only non-corrosive materials
  - b. Smart condensate neutralizer with capability of monitoring PH levels. Neutralizer to also monitor water temperatures, monitor/record water flow, detect CO, flue gas or water leaks with audible/visual alarm and alerts to app.
9. Venting:
- a. Exhaust vent shall be PVC, CPVC, Polypropylene, Stainless steel (AL29-4C) compatible with positive pressure, condensing flue gas service.
  - b. The minimum exhaust vent duct size for each water heater is six-inch diameter.
  - c. Combustion-Air Intake: Water heaters shall be capable of drawing combustion air from the outdoors via a metal or PVC duct connected between the water heater and the outdoors.
  - d. The minimum sealed combustion air duct size for each water heater is 4" diameter
  - e. Common Vent and Common Combustion Air up to 4 units. Consult manufacturer for common vent and combustion air sizing.
- I. Capacity and Characteristics: See schedule sheet on drawings.

## 2.3 DOMESTIC-WATER HEATER ACCESSORIES

- A. Domestic-Water Expansion Tanks:
- 1. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
  - 2. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
  - 3. Construction:
    - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
    - b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
    - c. Air-Charging Valve: Factory installed.
- B. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."
- 1. Comply with requirements for balancing valves specified in Section 221119 "Domestic Water Piping Specialties."
- C. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1, manually operated. Furnish for installation in piping.

- D. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include 1/2-psig (3.5-kPa) pressure rating as required to match gas supply.
- E. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.
- F. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.
  - 1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4.
- G. Pressure Relief Valves: Include pressure setting less than working-pressure rating of domestic-water heater.
  - 1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4.
- H. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.

## 2.4 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect assembled domestic-water heaters specified to be ASME-code construction, in accordance with ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
- C. Domestic-water heaters will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
  - 1. Maintain manufacturer's recommended clearances.
  - 2. Arrange units so controls and devices that require servicing are accessible.
  - 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 6. Anchor domestic-water heaters to substrate.
- B. Install domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."
- C. Install gas-fired, domestic-water heaters in accordance with NFPA 54.
1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
  2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
  3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
  4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 231123 "Facility Natural-Gas Piping."
- D. Install commercial domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment".
- E. Install pressure relief valves in water piping for domestic-water heaters without storage. Extend domestic-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- F. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."
- G. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- H. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping," and comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- I. Install piping-type heat traps on inlet and outlet piping of domestic-water heaters without integral or fitting-type heat traps.
- J. Fill domestic-water heaters with water.
- K. Charge domestic-water expansion tanks with air to required system pressure.
- L. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water shall contain less than 0.25 percent of lead by weight.

### 3.2 PIPING CONNECTIONS

- A. Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."
- B. Comply with requirements for gas piping specified in Section 231123 "Facility Natural-Gas Piping."
- C. Drawings indicate general arrangement of piping, fittings, and specialties.
- D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

### 3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Domestic-water heaters will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports.

### 3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain gas-fired, tankless domestic-water heaters. Training shall be a minimum of two hours.

END OF SECTION 22 34 00

## SECTION 22 43 00

### HEALTHCARE PLUMBING FIXTURES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. See schedules on drawings for items not included in this Section. Section Includes:
  - 1. Healthcare water closets.
  - 2. Flushometer valves.
  - 3. Toilet seats.
  - 4. Healthcare shower valves.
  - 5. Healthcare bathing units.
  - 6. Supply fittings.
  - 7. Waste fittings.
  - 8. Grout.
- B. Related Requirements:
  - 1. Section 224500 "Emergency Plumbing Fixtures" for emergency showers and eye-wash units.

##### 1.3 ACTION SUBMITTALS

- A. Product Data:
  - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fixtures.
  - 2. Rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Diagrams for power, signal, and control wiring.

##### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For plumbing fixtures and faucets.
  - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
    - a. Servicing and adjustments of flushometer valves and electronic sensors.

## 1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Material: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
  - 2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
  - 3. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than six of each type.
  - 4. Toilet Seats: Equal to 5 percent of amount of each type installed.

## PART 2 - PRODUCTS

### 2.1 SOURCE LIMITATIONS

- A. Obtain each product type from single manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A112.19.2/CSA B45.1 for vitreous-china plumbing fixtures.
- B. Comply with ASME A112.19.3/CSA B45.4 for stainless steel plumbing fixtures.
- C. Comply with ASSE 1037/ASME A112.1037/CSA B125.37 for flush valves.
- D. Comply with ASME A112.19.5/CSA B45.15 for flush valves and spuds for water closets.
- E. Comply with ASME A112.18.1/CSA B125.1 for plumbing supply fittings.
- F. Comply with ASME A112.18.2/CSA B125.2 for plumbing waste fittings.
- G. Comply with IAPMO Z124.5 for water-closet (toilet) seats.
- H. Comply with ASME A112.6.1M for plumbing fixture supports.
- I. Comply with ASSE 1016/ASME A112.1016/CSA B125.16 for shower valves.
- J. Comply with ICC A117.1 for ADA-compliant, accessible plumbing fixtures and installation.
- K. Comply with ASTM A1045 for flexible PVC gaskets used in connection of vitreous-china water closets to sanitary drainage systems.
- L. Comply with ASME A112.4.3 for plastic fittings used in connection of vitreous-china water closets to sanitary drainage systems.
- M. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- N. Faucets and bubblers intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority



Having Jurisdiction (AHJ), and with NSF 61/NSF 372 or are certified in compliance with NSF 61/NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

## 2.3 HEALTHCARE WATER CLOSETS

### A. Healthcare Water Closets, Vitreous China, Floor Mounted, Floor Outlet, Top Spud, Accessible:

1. Bowl:
  - a. Material: Vitreous china.
  - b. Type: Siphon jet.
  - c. Style: Flushometer valve.
  - d. Height: ADA compliant.
  - e. Rim Contour: Elongated with bedpan lugs or slots.
  - f. Water Consumption: 1.28 gal. (4.8 L) per flush
  - g. Spud Size: NPS 1-1/2 (DN 40).

### B. Healthcare Bariatric Water Closets, Stainless Steel, Floor Mounted, Floor Outlet, Top Spud, Accessible:

1. Bowl:
  - a. Material: Stainless steel.
  - b. Finish: Satin.
  - c. Type: Siphon jet.
  - d. Style: Flushometer valve.
  - e. Height: ADA.
  - f. Rim Contour: Elongated with bedpan lugs or slots.
  - g. Water Consumption: 1.28 gal. (4.8 L) per flush.
  - h. Spud Size: NPS 1-1/2 (DN 40).

## 2.4 FLUSHOMETER VALVES

### A. Lever-Handle, Diaphragm Flushometer Valves:

1. Minimum Pressure Rating: 125 psig (860 kPa).
2. Features: Integral check stop, backflow-prevention device, and outlet-tube-mounted bedpan washer.
3. Material: Brass body with corrosion-resistant components.
4. Exposed Flushometer-Valve Finish: Chrome plated.
5. Style: Exposed.
6. Consumption: 1.28 gal. (4.8 L) per flush.
7. Minimum Inlet: NPS 1 (DN 25).
8. Minimum Outlet: NPS 1-1/4 (DN 32), extended length.

## 2.5 TOILET SEATS

### A. Toilet Seats:

1. Material: Plastic with antimicrobial agent.
2. Type: Commercial heavy duty.
3. Shape: Elongated rim, open front.
4. Hinge: Check.
5. Hinge Material: Noncorroding metal.
6. Color: White.

## 2.6 HEALTHCARE SHOWER VALVES

### A. Healthcare Shower Valves, Pressure-Balance Mixing Valve:

1. Valve:
  - a. Body Material: Solid brass.
  - b. Finish: Polished chrome plate.
  - c. Maximum Flow Rate: 2.5 gpm (9.5 L/min.) unless otherwise indicated.
  - d. Mounting: Exposed.
  - e. Operation: Single-handle, twist or rotate control.
  - f. Antiscald Device: Integral with mixing valve.
  - g. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water-supply connections.
  - h. Indicators: For hot and cold water.
2. Shower Head:
  - a. Type: Ball joint with arm and flange.
  - b. Shower Head Material: Metallic with chrome-plated finish.
  - c. Spray Pattern: Adjustable.
  - d. Integral Volume Control: Not required.
  - e. Shower-Arm, Flow-Control Fitting: Not required.

## 2.7 HEALTHCARE BATHING UNITS

### A. Healthcare Bathing Units, Side Entry, Fixed Height:

1. Fixture: Plastic-tub, institutional bath fixture with integral controls.
  - a. Tub Size: 60 by 30 inches (1524 by 762 mm).
  - b. Controls: Vacuum breakers on supplies, thermostatic mixing valve, tub fill spout, and handheld shower head.
2. Supply Connections: NPS 3/4 (DN 20) with shutoff valve.
3. Drain: Manufacturer's standard NPS 1-1/2 (DN 40) with tailpiece.
4. Drain Piping: NPS 1-1/2 (DN 40) cast-brass P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2. Include combined drain piping if two drains.
5. Lift System: Required.
6. Unit Electrical Characteristics:
  - a. Volts: 120
  - b. Phase(s): One
  - c. Hertz: 60.
  - d. Full-Load Amperes:
  - e. Minimum Circuit Ampacity:
  - f. Maximum Overcurrent Protection:

## 2.8 SINK FAUCETS

### A. Sink Faucets, Manual-Operation Mixing Valve:

1. Configuration: Hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
2. Body Type: Centerset.

3. Body Material: Solid brass.
4. Finish: Chrome plated.
5. Maximum Flow Rate: 2.2 gpm (8.3 L/min.).
6. Control:
  - a. Wrist-blade, 4-inch (102-mm) handle(s).

7. Mounting Type: Deck, exposed.
8. Spout Type: Rigid gooseneck.
9. Vacuum Breaker: Required for hose outlet.
10. Spout Outlet: Laminar flow.

B. Sink Faucets, Automatic, Hard-Wired, Electronic-Sensor-Operated Mixing Valve:

1. Configuration: Hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
2. Body Type: Centerset.
3. Body Material: Solid brass.
4. Finish: Polished chrome plate.
5. Maximum Flow Rate: 2.2 gpm (8.3 L/min.) unless otherwise indicated.
6. Mounting Type: Deck, concealed.
7. Spout Type: Rigid.
8. Vacuum Breaker: Required for hose outlet.
9. Spout Outlet: Laminar flow.

## 2.9 SUPPLY FITTINGS

- A. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless steel wall flange.
- B. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- C. Operation: Wheel handle.
- D. Risers: NPS 1/2 (DN 15) chrome-plated, rigid-copper pipe and brass straight or offset tailpieces or chrome-plated, soft-copper flexible tube.

## 2.10 WASTE FITTINGS

- A. Drain: with NPS 1-1/2 (DN 40) tailpiece.
- B. Trap:
  1. Size: NPS 1-1/2 (DN 40).
  2. Material:
    - a. Stainless steel, two-piece trap and swivel elbow with 0.012-inch- (0.30-mm-) thick, stainless steel tube to wall; and stainless steel wall flange.

## 2.11 GROUT

- A. Characteristics: Nonshrink; recommended for interior and exterior applications.

- B. Design Mix: 5000 psi (34.5 MPa), 28-day compressive strength.
- C. Packaging: Premixed and factory packaged.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls, floors, cabinets, and counters for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Install healthcare plumbing fixtures level and plumb in accordance with rough-in drawings.
- B. Install supports, affixed to building substrate, for wall-mounted fixtures.
  - 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
  - 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
  - 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install floor-mounted healthcare water closets on bowl-to-drain, connecting fitting attachments to piping or building substrate.
- D. Install counter-mounted fixtures in, and attached to, casework.
- E. Install water-supply piping with stop on each supply to each fixture to be connected to water-distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
  - 1. Exception for use of ball or gate valve if supply stops are not specified with fixture. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."
- F. Install flushometer valves on healthcare water closets.
- G. Install flushometer valves for accessible healthcare water closets, with lever handle mounted on wide side of compartment.
- H. Install toilet seats on healthcare water closets.
- I. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts, if faucets are not available with required rates and patterns. Include adapters if required.
- J. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- K. Install traps on fixture outlets.

1. Exception for omission of trap on fixtures with integral traps.
- L. Set healthcare showers in leveling bed of cement grout.
- M. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."
- N. Seal joints between healthcare plumbing fixtures, counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
- O. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

### 3.3 PIPING CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with requirements for water piping specified in Section 221116 "Domestic Water Piping."
- C. Comply with requirements for soil and waste drainage piping and vent piping specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Comply with requirements for atmospheric vent piping specified in Section 221316 "Sanitary Waste and Vent Piping."
- E. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

### 3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
  1. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (13 mm) high.

### 3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning healthcare plumbing fixtures, fittings, and controls.

- B. Adjust water pressure at faucets and flushometer valves to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

### 3.6 CLEANING AND PROTECTION

- A. After installing healthcare plumbing fixtures, inspect and repair damaged finishes.
- B. Clean healthcare plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed fixtures and fittings.
- D. Do not allow use of healthcare plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 43 00

SECTION 22 45 00

EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

- A. Section Includes:
  - 1. Eye/face wash equipment.
  - 2. Water-tempering equipment.

1.3 DEFINITIONS

- A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
- C. Portable, Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid supply.
- D. Tepid: Between 60 and 100 deg F (16 and 38 deg C).

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.
- B. Shop Drawings:
  - 1. Plans, elevations, sections, and details.
  - 2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
  - 4. Diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Field Quality-Control Submittals:

1. Field quality-control reports.
- B. Emergency fixture third-party certification documentation.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For emergency plumbing fixtures.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ANSI/ISEA Z358.1 for emergency plumbing fixtures including third-party certification of fixtures.
- B. Comply with ASSE 1071 for temperature-actuated mixing valves for plumbed emergency fixtures.
- C. Comply with ASME A112.18.1/CSA B125.1 for water-supply fittings.
- D. Comply with ASME A112.18.2/CSA B125.2 for plumbing waste fittings.
- E. Comply with NSF 61 and NSF 372 for fixture materials that will be in contact with potable water.
- F. Comply with requirements in ICC A117.1 for plumbing fixtures for people with disabilities.
- G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

### 2.2 EYE/FACE WASH EQUIPMENT

- A. Eye/Face Wash Units - Standard, Wall Mounted, Plumbed:
  1. Source Limitations: Obtain eye/face wash units, standard, wall mounted, plumbed, from single manufacturer.
  2. Capacity: Not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
  3. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
  4. Control-Valve Actuator: Paddle.
  5. Spray-Head Assembly: Two or four receptor-mounted spray heads.
  6. Receptor: Chrome-plated brass or stainless steel bowl.
  7. Drain Piping:
    - a. Size: NPS 1-1/4 (DN 32) minimum.
    - b. Finish: Chrome-plated brass.
    - c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2.
  8. Mounting: Wall bracket.
  9. Accessories:
    - a. Electric alarm with flashing light and horn.



- b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge.
- c. Flow switch; single pole.
- d. Dust covers.
- e. Magnetically actuated proximity switch.
- f. Scald protection valve.

## 2.3 WATER-TEMPERING EQUIPMENT

- A. Water-Tempering Equipment - Hot and Cold Water:
  - 1. Source Limitations: Obtain water-tempering equipment, hot and cold water, from single manufacturer.
  - 2. Description: Factory-fabricated equipment with thermostatic mixing valve.
    - a. Thermostatic Mixing Valve: Designed to provide 65 deg F (19 deg C)] tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F (3 deg C) throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
    - b. Supply Connections: For hot and cold water.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION OF EMERGENCY PLUMBING FIXTURE

- A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
- B. Install fixtures level and plumb.
- C. Fasten fixtures to substrate.
- D. Install shutoff valves in water-supply piping to fixtures, to facilitate maintenance of equipment. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."
  - 1. Exceptions:
    - a. Omit shutoff valve on supply to group of plumbing fixtures that includes emergency equipment.
    - b. Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.

- E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 221116 "Domestic Water Piping."
- F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- G. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."
- H. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

### 3.3 PIPING CONNECTIONS

- A. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 221116 "Domestic Water Piping."
- B. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."
- C. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

### 3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
  - 1. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (13 mm) high.

### 3.5 IDENTIFICATION

- A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 220553 "Identification for Plumbing Piping and Equipment."

### 3.6 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.
- B. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection.
  - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 5. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.7 ADJUSTING

- A. Operate and adjust emergency plumbing fixtures and controls. Replace damaged and malfunctioning fixtures and controls.
- B. Adjust or replace fixture flow regulators for proper flow.
- C. Adjust equipment temperature settings.

### 3.8 CLEANING AND PROTECTION

- A. Clean emergency plumbing fixtures with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed emergency plumbing fixtures and fittings.
- C. Do not allow use of emergency plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 45 00

SECTION 22 47 13

DRINKING FOUNTAINS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

- A. Section Includes:
  - 1. Drinking fountains.
  - 2. Bottle filling stations.
  - 3. Supports.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of drinking fountain and bottle filling station.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  - 2. Include operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
  - 1. Include diagrams for power wiring.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For drinking fountains and bottle filling stations to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filter Cartridges: Equal to 10 percent of quantity installed for each type and size indicated, but no fewer than 2 of each.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

#### A. Standards:

1. Drinking fountains and bottle filling stations intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 or NSF 372, or be certified in compliance with NSF 61 or NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
2. Comply with ASME A112.19.3/CSA B45.4 for stainless steel drinking fountains and bottle filling stations.
3. Comply with NSF 42 and NSF 53 for water filters for drinking fountains and bottle filling stations.
4. Comply with ICC A117.1 for accessible drinking fountains and bottle filling stations.

### 2.2 DRINKING FOUNTAINS

#### A. Drinking Fountains - Surface Wall-Mounted, Stainless Steel:

1. Source Limitations: Obtain surface wall-mounted, stainless steel drinking fountains from single source from single manufacturer.
2. Type: Vandal resistant.
3. Receptor(s):
  - a. Type: Slab.
  - b. Shape: Rectangular
  - c. Back Panel: Stainless steel wall plate behind drinking fountain.
  - d. Bubblers: One for each receptor, with adjustable stream regulator, located on deck.
  - e. Drain: Grid type with NPS 1-1/4 (DN 32) tailpiece.
4. Maximum Water Flow: 0.15 gpm (0.0095 L/s).
5. Control: Push bar.
6. Supply: NPS 3/8 (DN 10) with shutoff valve.
7. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 (DN 32) chrome-plated brass P-trap and waste.
8. Filter: One or more water filters with capacity sized for unit peak flow rate.
9. Support: Provide manufacturer's mounting plate and drinking fountain carrier.
10. Drinking Fountain Mounting Height: Accessible in accordance with ICC A117.1.

### 2.3 BOTTLE FILLING STATIONS

#### A. Bottle Filling Station - Surface Wall-Mounted, Stainless Steel:

1. Source Limitations: Obtain surface wall-mounted, stainless steel, bottle filling stations from single source from single manufacturer.

2. Type: Vandal resistant.
3. Cabinet: Stainless steel.
4. Bottle Filler: Push-button activation. Fill rate 0.5 to 1.5 gpm (0.03155 to 0.09464 L/s).
5. Drain: Grid type with NPS 1-1/4 (DN 32) tailpiece.
6. Supply: NPS 3/8 (DN 10) with shutoff valve.
7. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 (DN 32) brass P-trap.
8. Filter: One or more water filters complying with NSF 42 and NSF 53 and with capacity sized for peak flow rate.
9. Support: Provide manufacturer's mounting plate and drinking fountain carrier.
10. Bottle Filling Station Mounting Height: Accessible in accordance with ICC A117.1.

## 2.4 SUPPORTS

- A. Drinking Fountain Carrier:
  1. Standard: ASME A112.6.1M.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls and floors for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- B. Install recessed, drinking fountains and bottle filling stations secured to wood blocking in wall construction.
- C. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
- D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523.12 "Ball Valves for Plumbing Piping".
- E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping".

- G. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

### 3.3 PIPING CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Install ball shutoff valve on water supply to each fixture. Install valve upstream from filter for drinking fountain. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping".
- D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

### 3.4 ELECTRICAL CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
- C. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
  - 1. Nameplates to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (13 mm) high.

### 3.5 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.

### 3.6 CLEANING

- A. After installing fixtures, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.
- C. Provide protective covering for installed fixtures.
- D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 47 13

## SECTION 230000

### GENEREAL REQUIREMENTS FOR HVAC

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS:

- A. Division 01 Specifications, General and Supplemental Requirements apply to this section with additions and modifications specified herein.
- B. Instructions to Bidders, Bidding Forms, Forms of Agreement between Owner and Contractor, Contract Award Date, Starting and Completion Dates, Conditions of the Contract, Insurance Requirements, and other Owner Requirements will be furnished separately by the Owner. These documents, as well as any addenda issued, shall form a part of these Specifications, and this Contractor shall consult them in detail for instructions pertaining to their work.
- C. Each trade contractor shall receive all drawings and specification sections issued as part of the overall bid package. All contractors are to receive, review, and coordinate all of their work as shown or referenced on the other trade documents. All work shown or referenced on the other trade documents shall be included as part of the overall project scope for that particular discipline and trade.

##### 1.3 SCOPE OF WORK:

- A. These specifications and accompanying drawings are intended to cover the furnishing of all labor, material, and equipment and superintendence of the HVAC System for this project. They are also intended to cover performing all miscellaneous operations including excavations and backfilling, cutting, channeling, chasing, and patching necessary for the installation of the HVAC systems, as shown on the drawings, as hereinafter specified, as directed by the Engineer, or as may be required for a complete and fully functional HVAC installation.
- B. It is the intent and purpose of these specifications and accompanying drawings to cover and include each item, all materials, machinery, apparatus, and labor necessary to properly install, equip, adjust, and put into perfect operation the respective portions of the installations specified and to so interconnect the various items or sections of the work as to form a complete and properly operating whole.
- C. Drawings and specifications have been prepared with best knowledge of conditions available at the time of design and are intended to be complementary. What is called for by one shall be as binding as if called for by both. Where conflicts occur between drawings and specifications, or between the HVAC documents and the documents of other disciplines, the situation shall be brought to the attention of the Design Professional before the work in question is installed. In case of conflict between provisions of the Specifications or between the drawings and the specifications, the more stringent requirement shall govern. Where a requirement is applied to a specific product, condition, system, or Specification Section which conflicts with a more general requirement elsewhere, the specific shall supersede the general. If any obscurities or discrepancies exist, they shall be brought to the attention of the Design Professional before bids



are submitted. If they are not discovered before bids are submitted, the Design Professional shall be notified and shall render a decision. This decision shall be final.

- D. Any equipment, apparatus, machinery, material, and small items not mentioned in detail, and labor not hereinafter specifically mentioned, which may be found necessary to complete or perfect any portion of installation in a substantial manner, and in compliance with the requirements stated, implied or intended in these specifications shall be furnished without extra cost. This shall include all materials, devices, or methods peculiar to the machinery, equipment, apparatus, or systems furnished and installed as part of the HVAC work and shall include major components if so required.
- E. The general arrangement of piping, ductwork and equipment shall be as identified on the contract drawings. Carefully examine all contract drawings and be responsible for the proper fitting of materials and equipment in each location as indicated. Inasmuch as the drawings are generally diagrammatic, due to their small scale, it is not possible to indicate all offsets, fittings, and accessories, as may be required in the final installation. Carefully investigate the site, structural, and finish conditions affecting their work and arrange such work, accordingly, providing such fittings and accessories as may be required to meet such conditions, at no additional cost to the Owner. The right to make any reasonable change in location of apparatus, equipment, outlets or routing of conduit and wiring, up to the time of roughing-in, is reserved by the Design Professional without involving any additional expense to the Owner.
- F. Should a bidder find discrepancies in or omissions from the drawings or specifications they shall notify the Design Professional before submitting their bid proposal. The Design Professional shall then send written instructions, via Addendum, to all known bidders. Oral instructions shall not be binding to either the Design Professional or the Owner.
- G. In the case of discrepancies or conflicts between the Drawings and Specifications, typically the Drawings will take precedence in the case of quantitative issues, while the Specifications will take precedence for qualitative issues; or as specified in other Divisions; however, when the scale and date of the Drawings are the same, or when a discrepancy exists within the Documents and specific written direction cannot be obtained from the Design Professional, Bidders shall include the most stringent requirements. Obtain written clarification from the Engineer prior to installation.
- H. Any such items not brought to the attention of the Design Professional prior to submission of the bids shall be subject to the interpretation of the Design Professional. All such interpretations shall be accepted by the Contractor and shall be incorporated into the construction in a timely manner, at no additional cost to the contract.
- I. These Specifications are arranged in accordance with the Master Format 2016, 35 Division format. The Specification is to be read as a whole. Items or work called for on one paragraph or Section, shall be applicable to the entire work, unless specifically indicated otherwise. Specific contract scopes shall be as determined by the Prime Contractor or Construction Manager.

#### 1.4 DEFINITIONS:

- A. The following are definitions of words found in the various Sections of Divisions 23 and on the associated Mechanical drawings:
  - 1. "Concealed" shall indicate hidden from normal sight in furred spaces, shafts, ceiling spaces, walls, and partitions.
  - 2. "Exposed" shall indicate work normally visible, including work in Mechanical or Electrical equipment rooms, tunnels, and similar spaces.

3. "Provide" (and tenses of "provide") – shall indicate "supply and install, complete in all respects, for a complete and fully functional installation."
4. "Install" (and tenses of "install") – shall indicate "secure in position, make all final connections complete, test, verify and certify for a complete and fully functional installation."
5. "Furnish" (and tenses of "furnish") – shall indicate "supply only, complete with all required accessories, mounting hardware, etc., for installation by others, or as spare "attic" stock for the Owner's future use."
6. "Engineer" shall indicate person, firm or Corporation representing the Owner, and identified as such in the Contract Documents. The terms "Engineer" and "Architect" may be used interchangeably throughout the documents.
7. "Authority Having Jurisdiction (AHJ)" shall indicate the organization, office, or individual responsible for enforcing the requirements of the applicable codes or standards in the location where the project is to be constructed.
8. "BAS" shall indicate Building Automation System, and which shall also refer to by equivalent to references to "ATC" – Automatic Temperature Controls, "BMS" – Building Management System or "FMS" – Facility Management System. Any and all of these terms and acronyms may be used interchangeably to refer to the same functional system, specified under Divisions 21 - 25.

#### 1.5 LAWS, REGULATIONS AND CODES:

- A. Perform all work in strict compliance with all laws, regulations, and/or codes applying, including all Federal, State, and local codes and any other authority having jurisdiction. Wherever drawings or specifications conflict with such regulations they shall be made to conform, and approval of the Design Professional obtained on such changes as may be involved.

#### 1.6 QUALITY ASSURANCE:

- A. Comply with the requirements of the following codes and/or standards:

1. ASHRAE Handbook
2. ASHRAE Published Standards
3. ASHRAE 15 – Safety Code for Mechanical Refrigeration
4. ASHRAE 34 – Number Designation and Safety Classification of Refrigerants
5. ASHRAE 62 – Ventilation for Acceptable Indoor Air Quality
6. ASHRAE 90.1 – Energy Design for New Buildings
7. ANSI
8. ASME
9. ASTM
10. UL
11. NEMA
12. AMCA
13. ARI
14. NEC
15. IBC 2018
16. IECC 2018
17. IMC 2018
18. Life Safety Code – NFPA 101
19. NFPA Published Standards
20. SMACNA – Standards for Ductwork
21. Pennsylvania Air Pollution Control Act, Title 5 (DEP)
22. Pennsylvania Code – Health Department
23. Pennsylvania Uniform Construction Code (UCC)
24. City and Local Codes

- B. All packaged equipment shall be independently Third Party labeled as a system for its intended use by a Nationally Recognized Testing Laboratory (NRTL) in accordance with the OSHA Federal Regulations 29CFR1910.303 and .399, as well as NFPA Pamphlet #70 and National Electric Code (NEC), Article 90-7.

1.7 PERMITS, FEES, AND CERTIFICATES OF APPROVAL:

- A. Unless stated otherwise in General Conditions or Division 01, obtain and pay for all permits, fees, and licenses required, including those of utilities and Agencies. Provide copies to Design Professional in the quantity requested.
- B. "Fees" shall include connection charges construction costs, and other such charges by utility companies or service providers. Ascertain such charges during bidding period and include bid price.

1.8 REQUEST FOR INFORMATION (RFI):

- A. Contractor is responsible for submitting Requests for Information (RFI)s when discrepancies arise, logical discrepancies are found on the contract documents, or clarification is necessary. All RFIs must be clearly written and submitted with a suggested solution. All RFIs regarding changes to the intent indicated on plans must be accompanied by sketches, explanation, site pictures, and all other instruments necessary, to clearly convey the issue at hand and the suggested solution. The RFI process may only be utilized for legitimate purposes. RFIs may not be utilized to submit deviation or substitution requests, nor requesting confirmation of scope for items clearly defined on the contract documents, nor related to clarifications that should be resolved through the Contractor's coordination efforts. RFIs that do not comply will be summarily rejected and any delays caused as a result are the responsibility of the Contractor. In cases where the Contractor does not submit an RFI to clarify an issue and incorrectly proceeds, all work required to resolve such issues to be in compliance with the intent of the contract documents, as determined by the Engineer, shall be the Contractor's responsibility and at no additional cost to the project.
- B. The contractors are required to carefully examine all architectural and structural drawings for the building as well as all of the drawings for electrical trades, IT/AV/Security Trades, mechanical trades, plumbing trades and fire protection trades and be responsible for the proper fitting of all material and equipment into the building as planned and without interference with other piping, ductwork, conduit or equipment. Refer to the coordination drawing requirements. Proper judgment shall be exercised to secure best possible headroom, ceiling heights, door and window clearance, and space conditions throughout; to secure neat arrangement for piping, equipment, and conduit, and to overcome all local difficulties and interferences to best advantage. Approval for any and all changes to plans and specifications which may thus be incurred shall be obtained from the Design Professional before proceeding.

1.9 RECORD DRAWINGS:

- A. Throughout the construction keep an accurate, up-to-date record of all deviations of the work between that as shown on the drawings and that which is actually installed.
- B. Obtain a complete set of prints of the Mechanical drawings and note changes thereon. The design professional will provide the CAD files or Revit model for the contractor's use. Make a complete record in a neat and accurate manner, of all changes and revisions to original design which exist in completed work. As-Built markups shall be updated on a daily basis.

- C. Submit As-Built documents in electronic BIM file format. The project design files will be provided to the Contractor by the Design Professional following proper execution of the Document Release and Indemnity Form as provided by the Design Professional. The electronic files returned by the Contractor shall be fully compatible with the native Revit \*.rvt file format software used by the Design Professional to create the original documents. In addition, submit a complete set of drawings in PDF format.
  - D. Room names and numbers shall be brought up to date to reflect actual project room signage and designations, which may be different from room indications shown on the contract drawings.
  - E. The cost of preparing these record drawings shall be borne by the Contractor. When all revisions showing the work as finally installed are made, the prints and BIM files shall be submitted for review and approval by the Design Professional.
  - F. Record drawings shall be delivered to Owner within 30 days of project Substantial Completion.
- 1.10 OPERATION AND MAINTENANCE MANUALS:
- A. Provide for the Owner's Use one (1) hard copy printed version and three (3) electronic copies in PDF format of a facility Operation and Maintenance Manual.
    - 1. Each hard copy Manual shall be bound in an extra heavy duty three-ring loose-leaf binder with the following title lettered on the front "Record and Information Manual Homestead Wakefield Elementary School". No sheets larger than 8-1/2" x 11" shall be used, except sheets that may be neatly folded to 8-1/2" x 11" and used as a pullout.
    - 2. Each electronic format Manual shall be provided as a single .PDF file, fully bookmarked and indexed, containing all Owner's Manual data and project drawings.
  - B. Provide the following information in each Manual:
    - 1. Cuts of all equipment with manufacturer's technical specifications. Material shall be manufacturer's brochures, catalog cuts, parts lists, wiring diagrams, etc. Also include approved shop drawings.
    - 2. Operation, Maintenance and Servicing Procedures. Include frequency of inspection, cleaning and adjusting and other attention as may be required in accordance with manufacturer's instructions.
    - 3. Copy of project Warranty.
    - 4. Contact name, telephone number and email address for obtaining replacement parts and service for all equipment.
    - 5. Copy of all individual equipment warranties.
    - 6. Copies of all required Test Reports.
    - 7. USB drive with all Special Systems drawings in both PDF and editable format.
    - 8. Electronic copy of all Owners Instruction and Training Sessions.
  - C. Furnish qualified personnel to instruct the Owner's personnel in the maintenance and operation of all equipment and systems. Instructing personnel shall remain on the job continuously during working hours until such instruction is complete, but not less than 16 hours.
  - D. A video recording in digital format of the operator training session shall be made during this training period and the digital video submitted to the Owner with the Operation and Maintenance Manuals.

1.11 WARRANTY:

- A. The material and workmanship of all parts of the mechanical installations specified herein and shown on the drawings shall be warranted unconditionally for a period of two (2) years from date of Project Substantial Completion against mechanical and electrical defects arising from faulty materials or workmanship. Either replacement or repairs shall be made promptly on any defective materials or workmanship without charge for materials, equipment, or labor during that period.
- B. Manufacturer's warranties on equipment provided under this contract shall be included in the operating and maintenance manuals.
- C. See specification section regarding restrictions on Early Use of HVAC Equipment.

1.12 CORRECTION OF WORK AFTER FINAL PAYMENT AND WARRANTY:

- A. This article is supplementary to Warranty Provisions of Division 01 and General Conditions.
- B. Final payment shall not relieve the Contractor of responsibility for correction of faulty equipment, materials, and workmanship and, unless otherwise specified, they shall remedy any defects due thereto and pay for damage to other work resulting therefrom, which shall appear within the warranty period specified above.
- C. Include warranties by the respective equipment manufacturers which shall be subject to the terms and time limits defined under these Divisions of Specifications.
- D. Warranties furnished by Sub-Contractor and/or equipment manufacturers shall be countersigned by the related Prime Contractor for joint and/or individual responsibility for subject item.
- E. Manufacturers' equipment guarantees or warranties extending beyond the warranty period described herein shall be transferred to the Owner along with the Contractor's warranties.

1.13 COMMISSIONING:

- A. Commissioning: Division 23 Contractors and vendors shall be part of a total building and system commissioning effort as conducted by the Commissioning Agent. Each contractor shall provide a technician and tools required to assist and facilitate the commissioning agent, as outlined by the commissioning plan. Where applicable and required, the contractor shall secure and pay for a factory technician to be part of the startup, testing and commissioning team and efforts. Full scope of work and all related responsibilities will be defined in Commissioning documentation.
  - 1. All equipment shall be commissioned, and the operation of that equipment shall be checked by the installing contractor. Specific systems shall be commissioned when more than one contractor is involved in the installation or there is multiple system interface and control involved with that piece of equipment.
  - 2. The contractors shall check and verify all equipment nameplate data against the design parameters, prior to installation.
  - 3. The contractors shall submit a Spare Parts List for all equipment in the Maintenance and Operations Manuals to include, but not limited to the following:
    - a. Part Numbers.
    - b. Part and Equipment Description.
    - c. Quantity of Parts Required.
    - d. Lubrication Requirements.

- e. Full Warranty Information.
  - f. Complete Operation and Maintenance Manuals.
- B. Provide factory trained technician after successful startup, for on-site support. Allow for five (5) days on-site for this. These days may not be consecutive.
- C. Provide six (6) additional site visits, after hours, after successful commissioning in the first year. For additional training and troubleshooting.

## PART 2 - PRODUCTS

### 2.1 MATERIALS AND EQUIPMENT:

- A. All installed materials and equipment shall be new and the best of their kind and shall conform to the grade, quality and standards specified herein.
- B. Unless otherwise specifically stated, all materials and equipment offered under these specifications shall be limited to products regularly produced and recommended by the manufacturer for the service intended. This material and equipment shall have capacities and ratings sufficient to amply meet the requirements of the project. The capacities and ratings shall be in accord with engineering data or other comprehensive literature made available to the public by the manufacturer and in effect at the time of opening of bids.
- C. Equipment shall be installed in accordance with manufacturer's instructions for type and quality of each piece of equipment used. These instructions shall be obtained from the manufacturer and shall be considered part of these specifications. Type, capacity and application of equipment shall be guaranteed suitable to operate satisfactorily. No experimental material or equipment shall be permitted.

### 2.2 WORK INCLUDED:

- A. In addition to work described above under WORK DESCRIPTION, the work shall include but not necessarily be limited to the following:
  - 1. Furnish and install all new scope as noted herein and shown on drawings.
  - 2. Rigging of equipment and materials related to the HVAC Work.
  - 3. Concrete work as specified hereinafter.
  - 4. Excavation and backfill.
  - 5. Mounting of duct smoke detectors furnished under Division 28.
  - 6. Ductwork and piping leak testing.
  - 7. Pipe, valve, and equipment marking and tags. Painting as noted herein.
  - 8. Test, adjust and balancing of all ductwork, piping and equipment.
  - 9. Any and all shutdowns shall be scheduled with the Owner and performed at such times as the Owner may direct. Required premium time shall be included in the Contractors bid.
  - 10. Where the specification requires testing, factory and/or field start-up, commissioning, adjustments, warranty or other activity, such requirements shall apply to each individual phase of the work.
  - 11. Support of independent commissioning agent retained by Owner.
  - 12. Where work of one phase extends from or interfaces with previous work, services for the latter phase shall include previously installed components. At the end of all work all such systems or equipment shall be tested or adjusted in their entirety in completed form, even if tests are redundant with previous phases.
  - 13. Instruction and equipment manuals. Instruction of Owners representatives.

## 2.3 EXCAVATION AND BACKFILL:

- A. Perform all excavating and backfill necessary for work under this Contract. It is assumed that all excavation under this Contract will be soil excavation. In event that rock is encountered, the Contractor shall be compensated for rock excavation in accordance with the unit prices or soil and rock excavation. Bidder shall state in their proposal, the unit prices for soil and rock excavation and the unit prices for soil excavation to be omitted. Rock excavation shall consist of solid rock or boulders over two cubic yards in volume or other material which can only be removed by line drilling or chipping by power equipment; blasting will not be permitted. In event rock is encountered notify the Design Professional of its existence in the areas not to be excavated and accurate measurements of the extent of the rock actually removed shall be made and submitted to the Design Professional.
- B. Perform all excavating and backfill necessary under this contract. All excavation shall be unclassified, and includes the excavation and removal of all soil, shale, rock boulders, existing foundations, fill and every kind of sub-surface condition encountered in the contract area. No extra or additional compensation for excavation will be paid under this Contract.
- C. To protect persons from injury, and to avoid property damage, adequate barricade, construction signs, torches, lanterns, and guards shall be placed and maintained during the progress of the construction work and unit it is safe for traffic use. Rules and regulations of local authorities respecting safety provisions shall be observed.
- D. The excavation may be accomplished by machine to within 2 inches of the sub-grade elevation. The excavation shall be completed by hand to neat lines.
- E. Trenches shall be instrument graded using batter board and flow line and of sufficient width to provide a free working space of not less than 24 in. width and not greater than 12 in. on each side of the pipe barrel, whichever is greater. Trenches shall also be wide enough to thoroughly ram the backfilling around the pipe and to secure a firm bed.
- F. In earth excavation, the trench shall be carried to the invert of the pipe. Where rock excavation is encountered, the trench shall be carried to a point 6 in. below the construction. No construction shall be bedded directly upon rock but shall be cushioned by a 6 in. layer of selected crushed stone or gravel.
- G. Where material is removed below the grade of the bottom of a structure it shall be replaced with concrete of the same quality as the concrete in the structure. Where material is removed below the grade of a pipe trench it shall be replaced with a lean concrete mix. Make no excavation to depth below a line of slope one ft. rise on 2 ft. length from such excavation to bottom of footing on other construction.
- H. Any piping that is run in unstable ground shall be supported on 5'-0" centers with concrete or brick piers. These piers shall be not less than 12 inches square and must reset on solid ground. Brick piers shall be laid in cement mortar.
- I. Maintain banks at all times by means of shoring and bracing to avoid cave-in and make good any damage done to property or work of others due to failure to properly shore any excavation. Shoring done shall be removed after installation and test of lines have been approved. Material for shoring shall be placed in accordance with the regulations of the Department of Labor and Industry.
- J. All excavations shall be left open until inspected and approved by the Design Professional. After the work has been installed, tested, inspected, the excavation shall be backfilled with the best carefully selected materials free from stones, large pebbles, hard lumps on frozen earth.

Trenches shall not be backfilled until the work has been inspected and approved by the Design Professional. All backfill shall be made in 8 in. layers. The first 2 layers shall be fine earth, hand tamped. The remainder of the fill over new construction to the surface shall be ordinary approved excavated material placed in 8 in. layers and thoroughly compacted to not less than 90% of maximum Modified Density as determined by ASTM D 1557-70. No water soaking will be permitted. All excess materials shall be disposed of as directed. Seeding shall be by the Prime Contractor.

- K. Where excavation is required under existing walkways and roadways, surface shall be restored with new materials equivalent to the material originally used. Whole cement pavement blocks shall be removed and replaced; removal and repair of partial blocks is not permitted.

#### 2.4 PUMPING:

- A. Provide pumping equipment to pump all water to prevent it from collecting in trenches, basement areas, and any other excavations necessary to carry out contract requirements. Prepare run-off trenches as required to pump water into and use surplus earth to form dam at top of excavation to run back surface water.

#### 2.5 CHASES AND OPENINGS:

- A. Provide information to the appropriate trades regarding size and location of all openings and chases as required for the installation of this HVAC Work.
- B. Patching and repair of finishes will be by the Prime Contractor.
- C. Provide sleeves for pipes passing through poured concrete decks, footings, walls, etc. Cut all openings for piping passing through precast concrete or existing concrete or masonry. Such holes shall be cut with core drill or similar equipment. They shall not be cut with hammer and chisel, or with any power tool depending on impact for its cutting power.

#### 2.6 CONCRETE:

- A. Provide concrete work required for work performed under this Contract. Coordinate with work shown on Structural Drawings.
- B. Concrete shall have a compressive strength of 3,000 psi minimum at twenty-eight days. Placing of reinforcing steel and concrete shall be done according to the recommendations of the American Concrete Institute and Concrete Reinforcing Steel Institute, and all materials shall conform to American Society for Testing Materials Specifications, applicable to this work. Equipment pads shall be properly dowelled in with floor construction and shall have sloped bevels on all horizontal and vertical edges.
- C. Form work shall be of sufficient strength to maintain desired shape during pouring of concrete and tight enough to prevent leakage of the grout through joints.
- D. Submit shop drawings for approval showing dimensions, reinforcing, and dowelling.
- E. Provide at the time of pouring concrete, all necessary anchor bolts. Anchor bolts shall be the hook type, of proper size and length to suit the equipment. Anchor bolts shall be set in pipe sleeves of approximately twice the bolt diameter and one half the embedded length of the bolt. Assume full responsibility for proper emplacement of the bolts.



- F. Drop-in wedge anchor bolts or self-drilling anchors may be used in place of hook bolts. Minimum embedment in concrete of wedge anchor bolts shall be in accordance with manufacturer's instructions. Wedge anchor bolts shall be manufacturer by Phillips Drill Co. or USM Corp. Self-drilling anchors shall be manufactured by Phillips Drill Co.
- G. After equipment is set in place and bolted down, any space between equipment base and floor slab or foundation shall be completely filled with non-shrink grout equal to Master Builders Co., Ltd. Embeco 153 grout.

## 2.7 STARTERS AND PILOT DEVICES OR MOTOR CONTROLS:

- A. Combination magnetic motor starters shall be full voltage non-reversing with an adjustable instantaneous-trip circuit breaker or fused or unfused safety switch. Motor starters shall have UL508 symmetrical RMS ampere interrupting rating in accordance with equipment specifications or as required by Electrical Coordination Study specified in Electrical General Requirements: Division 26. Starters and protective devices shall be of sizes recommended by manufacturer for the motor to be controlled, but minimum size shall be NEMA size 1. Overloads shall be solid state type which provide both overcurrent as well as phase loss protection at motor.
- B. Combination magnetic motor starters shall be full voltage non-reversing with a fused safety switch. Starters and protective devices shall be of sizes recommended by manufacturer for the motor to be controlled, but minimum size shall be NEMA size 1.
- C. Starters, which are not combination shall be similar, but without circuit breaker or switch.
- D. For description of starters, refer to Division 23 and 26 Specifications. This Schedule describes which starters are combination, and if so, what type of device they require. This Schedule also indicates the type of pilot device(s), indicators, auxiliary relays, etc. to be supplied. In the absence of any such instruction, furnish non-combination starter with "hand-off-auto" selector switch, green "run" pilot light, and two (2) auxiliary contacts.
- E. Where starters or other devices are to be mounted outdoors, such as on a cooling tower, enclosures shall be NEMA Type 4. All other enclosures, unless otherwise noted, shall be NEMA Type 1.
- F. All starter control circuits shall be 120V (or 24 VAC if required to interface with BMS/BAS equipment). Voltage shall be derived from starter line voltage via fused control transformer. Control transformers shall have sufficient capacity to properly operate any auxiliary equipment, such as dampers, electro-pneumatic switches, or other devices. Provide transformers larger than manufacturer's standard size, as required by these conditions. Provide sufficient auxiliary contacts to properly interface with ATC equipment, or other devices interlocked with the motor in question.
- G. Manual starters shall be toggle type, in surface or flush enclosure as required, and with pilot light. Provide overload heaters unless the motor to be controlled is thermally protected.
- H. Unless otherwise noted, overload heaters shall be melting-alloy non-automatic-reset type. Overload heaters shall not be selected based on average published motor currents but shall be selected based on the actual nameplate current of motors and service factor as installed.
- I. Push buttons, selector switches, pilot lights and similar pilot devices shall be NEMA 1 or NEMA 4, as noted in D, above. Pilot lights shall be neon or transformer type. Provide manufacturer's standard engraved nameplates which display the control function of the device (or for pilot lights, the action indicated).

- J. Electrical Contractor shall install all individually mounted starters. Electrical Contractor shall provide line and load side power wiring. Coordinate with Mechanical Contractor for all BMS/BAS control interface/interlocks. Mechanical Contractor shall turn over all starters to the Electrical Contractor for installation. This Contractor shall furnish, install, and wire all other (pilot) devices, and provide cell control wiring for starters. See Division 23 "Sequence of Operations" Specification for additional details.
- K. All starters and controls shall be Square D, General Electric, Allen Bradley, Cutler-Hammer or Siemens.

## 2.8 ELECTRICAL WORK AND MOTORS:

- A. All electrical work shall be done in strict accordance with the requirements of the National Electrical Code and the Electrical Specifications. All electrically operated equipment shall bear an Underwriter's Laboratories label where labeling service is available for that type of equipment.
- B. All motor frames shall be grounded. Electric power, control and grounding connections shall be factory wired to an outlet box or terminal strip enclosure on the apparatus for easy connection by the Electrical Contractor.
- C. All motors shall be designed and constructed in accordance with the latest standards of the IEEE and NEMA and shall meet UL requirements. Motors shall run quietly under all operating conditions.
- D. See Division 23 Specification for additional details

## 2.9 WIRING FOR CONTROL SYSTEMS:

- A. This Article applies to wiring used for Automatic Temperature Control (ATC), Building Automation Systems (BAS), Building Management System (BMS), and similar types of control systems associated with work of Division 23.
- B. All wiring for control systems shall comply with Article 725 of the National Electrical Code, (NEC) or with Articles 760, 800, or 820 for control systems integrated into systems covered by those Articles.
  - 1. Particular attention shall be given to the requirements of the NEC for testing and labeling cables for use in plenums, risers, and other air-handling spaces.
- C. All wiring for control systems shall be of a type recommended by the system manufacturer and be installed in accordance with systems manufacturer's instructions.
- D. Cables must be in raceways when run through inaccessible ceilings, walls or chases. Comply with Division 26 Specifications, for types of raceways required and their installation requirements. Cables run on surfaces within 8' of finished floor must be in raceways where exposed to physical damage. Cables in mechanical spaces must be in raceways.
  - 1. Where cables enter or leave raceways, provide insulated bushing or protective grommet.
- E. Cables may be run without raceways above accessible ceilings; in hollow stud partitions; and where properly supported in unfinished spaces without ceilings.

- F. Cables run without raceways in concealed locations or unfinished spaces shall be supported by bridle rings or similar hangers attached to the building structure at maximum 5'-0" centers. Hangers and/or cables shall not be supported from pipes, ducts, or similar equipment. Cables shall not be supported by lying on or across framing members or structural elements.
  - G. Where cable is run exposed in finished areas, it shall be supported by bridle rings and beam clamps at maximum 4' intervals. All cables running along a given beam, joist, or truss shall be bundled together and run parallel to each other. Bundle shall be tied together at 2' intervals with T&B "Ty-raps" or equal nylon cable tie. Ty-raps shall be exposed one foot on either side of bridle ring supports. Cables shall be pulled as tight as possible and run as straight as possible.
    - 1. Where cables bend, bends shall be 90 degrees; parallel cables shall have symmetrical turns. Bending radius shall be no smaller than manufacturer's specification for level of cable involved. Individual cables shall be supported with metal straps listed for the purpose. All cables shall be run parallel with or perpendicular to building lines, plumb and true. Cable loops connecting to boxes or fittings shall be as short and neat as possible.
    - 2. See details on Electrical Drawings for general information regarding cable support. All cables run on steel structure will be painted to match steel; cable supports, ties, etc., must be installed prior to painting.
    - 3. Cables shall be maintained at a spacing of 6" from 120 V and higher voltage AC conductors, unless installed in a grounded metallic raceway.
  - H. Wiring with or without raceways shall be run continuously between terminal boxes and outlets. All splices shall be made in NEMA 1 boxes with terminal strips or other acceptable connectors and permanent labels to identify each wire and cable, both entering and leaving the box.
  - I. A separation of not less than 6" shall be maintained to heated pipelines.
  - J. Cable run above hung ceilings used for environmental air shall be specifically listed and labeled for the use or shall be installed in a raceway.
  - K. Wiring run without raceways through rated walls, floors and partitions shall be run in sleeves. All such sleeves shall be packed with fire-rated material.
  - L. Wiring for different systems shall be grouped and run separately from other systems and shall be identified as to the system it serves.
  - M. Where equipment to be provided is controlled with line voltage devices (thermostats, speed controllers, timers, etc.), these devices shall be furnished to the electrical contractor for mounting and wiring of same.
  - N. All electrical wiring in connection with the BAS shown on the electrical drawings shall be installed by the Electrical Contractor. Any wiring not shown but required for proper operation of the automatic temperature control system, shall be performed by the Control Contractor and shall be in complete accordance with National Electrical Code, latest edition, and the Electrical Contract Specifications.
- 2.10 FLASHING AND ROOFING WORK:
- A. The Contractor shall perform all cutting, patching, and sealing of existing roofs as required for the installation of all work under this Contract.
  - B. The contractor bears the complete responsibility for maintaining and obtaining the watertight integrity of the affected areas of the roofs both during and after the completion of construction.

- C. The Contractor shall provide all base flashings, counter flashings, and hot applied roofing materials necessary to properly flash and seal the roofs as required and to prevent any water or moisture leakage whatsoever from occurring as a result of this work.
- D. Unless noted otherwise, all flashings shall be minimum 24-gauge galvanized steel. Base flashings shall have minimum 4" roof flanges on all sides. Flanges of all base flashings shall be secured and stripped into existing roofing in accordance with the best practices and methods of the roofing trade for a watertight installation.
- E. All joints and seams of all flashings shall be continuously soldered.
- F. After installation, all exposed metal surfaces of base flashings shall be given two (2) applications of roofing coating.
- G. All roofing work shall be performed by first class mechanics experienced in the roofing trade.
- H. Contractor must exercise extreme care so as not to damage existing roofs while working thereon and they shall provide protection planking and plywood as required to achieve this result. Any damage to the existing roofs and their watertight integrity caused as a result of work being performed under this Contract shall be properly repaired by the Contractor to the satisfaction of and at no cost to the Owner.
- I. Refer to drawings for additional flashing details and roofing work required.

#### 2.11 SUBSTITUTIONS:

- A. Equipment may be shown or specified in several ways:
  1. Manufacturer and catalogue or model number with the words "no substitutions," "no equal," "(manufacturer) only," or words of similar respect. Contractor shall furnish the specified item.
  2. Several manufacturers and model numbers listed; or one manufacturer and model number, followed by "equals by (mfr A), (mfr B), (mfr C)," or words of similar respect.
    - a. If one of the manufacturers is listed on the drawings, that manufacturer shall be considered the basis of design. If none is so listed, the first manufacturer named in the Specification shall be considered the basis of design.
    - b. Where manufacturer's or supplier's name, style and catalog numbers are mentioned in the description of material and equipment in the specifications or on the drawings, it is to be understood that they are for the purpose of setting a standard.
    - c. If Contractor elects to furnish equipment other than the basis of design, they shall verify capacities, physical size, weight, electrical requirements, methods of connection to other parts of the system, and all other relevant data. Contractor shall be responsible for informing the Design Professional of all changes required to other equipment, spaces, structure, or systems in order to install the substituted equipment. They shall furnish all required shop drawings or sketches required for Design Professional to evaluate the required changes and shall be responsible for all costs associated with such changes, including costs of design or engineering, if such are necessary, and costs of other trades.
    - d. Accompany the request for substitution review with a table of comparisons listing pertinent features of both the specified and proposed materials including performance data, weight, material of construction, overall length, width, height dimensions, space required for replacement or maintenance access, motor type,

horsepower, voltage, phase service factor, and noise levels. Review of proposed substitution will not be made until receipt of the complete comparison tabulation.

3. Where manufacturer's or supplier's names are listed in conjunction with the manufacturer or supplier that is basis of design, they are given to approve the firm name only. Equipment or material submitted by such firms must meet the detailed technical specifications written for the respective item. Contractor shall be responsible for verifying capacities, physical sizes, weights, electrical requirements, and methods of connection to other parts of the system, etc. Contractor shall furnish all required shop drawings for equipment, and for its connection and installation.

B. If any substituted items are submitted after contracts have been awarded, and there is any question of equality of such items, samples may be required to be submitted both for the item specified and that to be substituted, or further proof of equality may be required to the entire satisfaction of the Design Professional. In no case shall additional remuneration be allowed because of the rejection of a substitute.

C. When the equipment is relocated to a place other than that shown on the drawings, or when equipment other than that specified is used, the Contractor shall pay the extra cost of required revisions such as structural steel, concrete, electrical, piping, etc.

D. The Design Professional's costs to evaluate substitutions and to revise Drawings and Specifications because of substitutions will be paid by the Contractor.

#### 2.12 SHOP DRAWINGS:

A. Refer also to Division 01.

B. Furnish shop drawings, catalog cuts, performance data and other required data to the Design Professional for approval for all material and equipment specified hereinafter. Sufficient data shall be submitted to show compliance with the requirements of the plans and specifications. All shop drawings submitted shall be first checked and corrected before submitting for approval. Approval for shop drawings by the Design Professional will not relieve the Contractor from responsibility for errors or omissions therein. All such errors or omissions must be made good by the Contractor irrespective of any approval by the Design Professional.

C. It is the responsibility of the manufacturer's representative and the installing contractor to thoroughly review all shop drawing equipment submittals and state in writing that the products meet or exceed the design specifications and design intent as indicated on the contract documents, prior to submitting them for review by the engineer.

D. The Prime Contractor or Construction Manager shall review and stamp all shop drawings noting their review process has taken place and that the shop drawings are in compliance with the design documents, prior to submitting the for review by the engineer. Any shop drawings found to not be in compliance shall be returned to the contractor stating such, with a copy of the statement (only) forwarded to the engineer.

E. On submissions beyond the initial one, clearly identify all of the changes made from the initial submittal those requested by the Design Professional. The Design Professional will review only those changes they requested and those identified by the Contractor.

F. The Engineer will review three submissions (one original submission and up to two revised submissions) on any single component requested for review. If the contractor and/or vendor fail to comply with the drawings, specifications, and/or review comments and additional

submissions are required, the cost for review and processing of those submissions will be borne by the contractor.

- G. The design documents are based and coordinated on the scheduled manufacturers. Any substitutions of products or materials (from those approved and listed in the specifications) must be thoroughly coordinated by the submitting contractor. This includes but is not limited to power, space, structural, control and performance requirements.
- H. Shop drawings required shall include, but not necessarily be limited to, the following:
  - 1. Shop drawings, cuts and catalogue information showing appearance, dimensions, performance, weight, etc., of all equipment, appurtenances, etc.
  - 2. Schedules of all materials showing type and manufacturer.
  - 3. Wiring diagrams and schematics for equipment.
  - 4. All special equipment and systems.
  - 5. Any special constructions.
  - 6. Other shop drawings as may be requested.
  - 7. Ductwork shop fabrication drawings. See also the requirements in Part Three of this Specification Section.
- I. Digital files of mechanical work will not be provided for the purpose of shop drawing preparation. Digital files of architectural plans, elevations, sections, etc. may be available for background purposes; it is the responsibility of the Contractor to confirm availability prior to bid.
- J. Shop drawings shall be submitted in a timely manner, taking due account of time requirements for processing, correcting and distributing the shop drawings to all persons or trades requiring the information, as well as time required for manufacture of the equipment. Design Professional will not be responsible for construction delays resulting from late submission of shop drawings, nor for delays caused by the need to correct and resubmit shop drawings which were not correct, which involved substituted equipment, or otherwise required review, correction and resubmission.
- K. If Contractor elects to proceed to install equipment for which approved Shop Drawings have not been received, they do so at their own risk; Design Professional is not obligated to accept such equipment or work, nor will Design Professional be liable for claimed costs or delays required by correction of such work.
- L. Identify each submittal, including shop drawings, catalog data, test reports, operation and maintenance manuals, and record documents, with the following data:
  - 1. Buyer's name.
  - 2. Project name.
  - 3. Project location.
  - 4. Buyer's purchase order number.
  - 5. Reference specification order number.
  - 6. Name of contractor making the submittal.
  - 7. Revision level of submittal and date of revision.
- M. For equipment, provide the following information on each submittal:
  - 1. Equipment tag number.
  - 2. Equipment description.
  - 3. Equipment manufacturer's contact information.
  - 4. Local equipment representative's contact information.

- N. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristic, finishes for materials, and installation and startup instructions for each type of product indicated.
1. Each control device labeled with setting or adjustable range of control.
- O. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Schematic flow diagrams showing all controlled equipment and control devices.
  2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
  3. Details of control panel faces, including controls, instruments, and labeling.
  4. Written description of sequence of operation.
  5. Trunk cable schematic showing programmable control unit locations and trunk data conductors.
  6. Listing of connected data points, including connected control unit and input device.
  7. System graphics indicating monitored systems, data point addresses, and operator notations.
  8. System configuration showing peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
- P. Shop Drawings shall be submitted and shall consist of a complete list of equipment and materials, including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. Shop drawings shall also contain complete wiring, routing, schematic diagrams, tag number of devices, software descriptions, calculations, and any other details required to demonstrate that the system will function properly. Drawings shall show proposed layout and installation of all equipment and the relationship to other parts of the work.
- Q. Shop Drawings shall be approved before any equipment is installed. Therefore, shop drawings must be submitted in time for review so that all installations can be completed per the project completion schedule. Ten (10) working days shall be allowed for submittals to be reviewed by the Engineer.
- R. All drawings shall be reviewed after the final system checkout and updated or corrected to provide "as-built" drawings to show exact installation. All shop drawings will be acknowledged in writing before installation is started and again after the final checkout of the system. The system will not be considered complete until the "as-built" drawings have received their final approval. The Contractor shall deliver a complete set of "as-built" drawings.
- S. On submissions beyond the initial one, clearly identify changes made from the initial submittal other than those requested by the Design Professional. The Design Professional will review only those changes they requested and those identified by the Contractor.

### **Shop Drawing Review Comment Definitions**

#### **A> No Exception Taken:**

The shop drawing or equipment submittal as submitted is approved without exception. No changes or corrections required. The materials, equipment or system submitted can be released for fabrication and construction. No Further Submission Required.

**B> Make Corrections Noted:**

The shop drawing or equipment submittal as submitted is not completely correct but is approved as noted. Make the corrections noted on the shop drawing or submittal. The materials, equipment or system submitted can be released for fabrication and construction once the corrections have been made. The submittal must be corrected and resubmitted for record unless noted by "E: Resubmit". See "E: Resubmit definition below.

**C> Submit Specified Item:**

The shop drawing or equipment submittal as submitted is missing a component of the system that it represents or is not of the approved and specified manufacturers. Submit the missing or incorrect item. The materials, equipment or system submitted cannot be released for fabrication and construction.

**D> No Further Submission Required:**

The shop drawing or equipment submittal as submitted is approved as noted. No changes or corrections required. The materials, equipment or system submitted can be released for fabrication and construction. No Further Submission Required.

**E> Resubmit:**

The shop drawing or equipment submittal as submitted is not approved. The shop drawing or equipment submittal needs significant corrections and does require another submission to verify that the comments and changes have been incorporated. Make the corrections noted on the shop drawing or submittal. The materials, equipment or system submitted cannot be released for fabrication and construction.

**F> Rejected:**

The shop drawing or equipment submitted is not as specified or a non-approved manufacturer or product and rejected.

**G> Resubmit for Record Only:**

Make the corrections noted on the shop drawing or submittal. The shop drawing or equipment submittal as submitted is approved with minor exception. Changes or corrections are required. The materials, equipment or system submitted can be released for fabrication and construction.

**PART 3 - EXECUTION**

**3.1 WORKMANSHIP:**

- A. All work shall be installed in a first class, neat and workmanlike manner by mechanics skilled in the trade involved. All details of the installation shall be mechanically correct. Should the Design Professional direct removal, change, or installation of any equipments or systems not installed in a neat and workmanlike manner, such changes shall be made by the HVAC Contractor at no expense to the Owner.
- B. Equipment shall be installed in strict accordance with manufacturer's instructions for type and capacity of each piece of equipment used. The Contractor shall obtain these instructions from the manufacturer and these instructions shall be considered part of these Specifications.



- C. Drawings are generally indicative of the work to be installed, but do not indicate all bends, fittings, and specialties which may be required, or the exact locations of all piping and ductwork. Contractor shall investigate structure and finish conditions affecting their work and arrange their work; accordingly, furnishing such fittings as may be required to meet such conditions. Contractor is responsible for exercising proper judgment to arrange their work and materials so as to avoid interference with other trades.
1. Riser diagrams and schematics generally indicate equipment to be used in various systems involved. This information may or may not be duplicated on the plans, but equipment shown on either plans or riser diagrams and schematics shall be provided as if shown on both.
  2. All grades, elevations, dimensions and clearances of equipment shown on drawings are approximate and shall be verified at site.
  3. Where work or equipment is referred to in singular terms, such reference shall be deemed to apply to as many items of work or equipment as required to complete entire installation.

### 3.2 LINES AND GRADES:

- A. Lay out work and establish heights and grades for work in strict accordance with the intent expressed by the drawings and all the physical conditions at the building and be responsible for the accuracy of same.

### 3.3 FIELD MEASUREMENTS:

- A. Before ordering any material or doing any work, verify all measurements at the building and site and be responsible for the correctness of same. No extra compensation will be allowed on account of differences between actual dimensions and measurements and those indicated on the drawings. Any difference which may be found shall be submitted to the Design Professional for consideration before proceeding any further with the work.

### 3.4 DELIVERY OF EQUIPMENT:

- A. Be responsible for delivery of equipment, unload and store in a manner not to interfere with the operation of other trades. Additional expense incurred because of equipment or material delivery delays shall be assumed by the responsible Contractor.

### 3.5 RESTRICTIONS ON EARLY USE OF HVAC EQUIPMENT:

- A. The HVAC equipment provided under this contract shall not be operated prior to the completion of construction of the building for reasons other than testing and balancing of the systems, unless specifically directed and/or approved by the Owner. This specifically prohibits the use of permanent equipment for the purposes of ventilating, heating and dehumidifying the building while under construction.
- B. Should a contractor choose to use any component of the permanent HVAC system (i.e. rooftop units, terminal units, etc.) for purposes other than stated above, they shall assume full responsibility for replacing or repairing any equipment damaged as a result of the use and pay all costs associated with the action required to make the equipment in "like new" conditions at the end of the project. This includes cleaning of ducts and coils, replacement of motors, extension of warranties, payment of design professional fees required to investigate and enforce this requirement, and the correction of any other detrimental conditions which is determined by the design professionals to be related to the early use of the equipment.

- C. Should the early use of equipment result in manufacturer's warranty being void, the contractor shall assume the cost of furnishing an equivalent warranty to the owner.
- D. Should fan motors be operated during construction, any motor determined by the owner or design professional to be exposed to airborne construction dust, such as generated by drywall sanding, shall be inspected by an independent 3rd party for damage. The costs of all required corrective actions shall be borne by the contractor responsible for the operation of the equipment.

### 3.6 PROTECTION OF WORK:

- A. All work, equipment and materials shall be protected at all times.
- B. All piping openings shall be closed with caps or plugs during installation. All equipment shall be tightly covered and protected against dirt, water, plaster, paint and other foreign material or mechanical injury during entire progress of installation. Make good all damage caused either directly or indirectly by workmen employed to fulfill requirements of the HVAC Work.
- C. Acoustically lined ductwork shall at all times be protected from weather.

### 3.7 REMOVAL OF RUBBISH:

- A. During the course of construction, periodically remove from the premises all rubbish resulting from work of this trade so as to prevent its accumulation. At the completion of the work contemplated under these Specifications remove from the building and site all rubbish and accumulated materials of whatever nature not caused by the other trades and leave work, and equipment free of all foreign matter including plaster, cement, and paint and leave in a clean, orderly, acceptable and usable condition

### 3.8 COORDINATION WITH OTHER TRADES:

- A. Work in conjunction with each of the other trades to facilitate proper and intelligent execution of work with minimum interference.
- B. Carefully examine all architectural and structural drawings for the building and drawings for electrical trade and other mechanical trades and be responsible for the proper fitting of all material and equipment into the building as planned and without interference with other piping, ductwork, conduit or equipment. Proper judgment shall be exercised to secure best possible headroom, door and window clearance, and space conditions throughout; to secure neat arrangement for piping, equipment and conduit; and to overcome all local difficulties and interferences to best advantage. Approval for any and all changes to plans and specifications which may thus be incurred shall be obtained from the Design Professional before proceeding.
- C. Contractor shall prepare preliminary sheet-metal shop drawings suitable for use in coordinating their work with the work of other trades. The Mechanical Contractor shall prepare and furnish CAD files of drawings at 1/4" = 1'-0" scale illustrating the coordination with all trades. Drawing shall indicate equipment access requirements, piping, ductwork and conduit in relation to all structural elements of the construction, including floor elevations; steel locations, size, and elevations; partitions locations; door locations and direction of swing; and all other information required to assure coordination of the electrical, sheet-metal and piping trades and fire protection in relation to the Architectural function of the project. Coordination meetings shall be held under the supervision of the Owner's Construction Manager and Prime Contractor. Each trade shall have proper representation at all coordination meetings for the purpose of detailing, on a print of the coordinated drawing mentioned above, the exact location and routing of their work. After the conclusion of the coordination at the working meetings, each trade shall sign the

coordinated print, copies of which shall be distributed by the GC to all contractors and parties concerned including the Owner. A print of each final coordination CAD drawing with the participants contractor's "signoff" signatures appended shall be submitted to the design professional for record.

- D. If contractor installs work so as to cause interference with work of other trades, they shall make necessary changes in work to correct the condition without extra charge.
- E. Dimensional layout plans of equipment rooms shall be made showing all bases, pads and inertia blocks required for mechanical equipment. Include dimensions of bases, bolt layouts, details, etc.
- F. Contractor shall furnish all necessary templates, patterns, etc. for installing work and for purpose of making adjoining work conform, furnish setting plans and shop details to other trades as required.

### 3.9 COORDINATION OF CONTROL EQUIPMENT:

- A. The HVAC Contractor shall furnish all starters, push buttons for local or remote control, controllers, pressure switches, aquastats, thermostats, float switches or similar items together with all appurtenances and accessories required to operate the equipment furnished under these specifications and necessary to perform the operating functions as specified, shown on the drawings, or otherwise required.
- B. Refer to Schedule of Control Equipment on Drawings for type of controls required. The Electrical Contractor will mount and provide power-wiring for all starters and will furnish and install all other safety switches or other line-disconnecting or protective devices. Where the starter and/or safety switch is an integral part of the equipment assembly, the assembly shall be furnished with the wiring complete between starter, controller and motor and the Electrical Contractor will make power connections only.
- C. All control wiring to automatic-operated switches, pressure switches, aquastats or other devices which actuate the starter or other items associated with the systems shall be furnished, installed and wired by the HVAC Contractor. The Electrical Contractor will supply 120V electric power to the control panels for these special systems to the extent shown on Electrical Drawings. All other wiring (including additional power circuit if required) shall be the responsibility of the HVAC Contractor.
- D. The HVAC Contractor shall carefully check the current characteristics available to each location before ordering motors.
- E. If procurement requirements necessitate a change in voltage, phase, horsepower or other characteristics of any motor, the HVAC Contractor shall obtain approval of such change from the Design Professional and shall be responsible for necessary arrangements for notifying the Electrical Contractor, and shall pay the costs, if any, required by the change, including Engineering costs.
- F. All electrical equipment furnished and installed under this contract shall be furnished with full complement of control equipment, control wiring, conduit and all other items necessary for satisfactory operation.
- G. The Electrical Contractor will complete all electrical power connections, through the disconnect and/or thermal cutouts, starter and motor terminals. They will be responsible for final power connections.

- H. The Electrical Contractor will be responsible for proper rotation of three phase equipment.
- I. All electrical work, equipment and material furnished under this Section shall be furnished and installed in accordance with Division 26 Electrical Specifications.
- J. All panels, relays, terminal boxes, contactors, circuit breakers, safety switches, motor starters and similar items shall be identified by Name, Function and/or Control. Nameplates shall be at least 1" x 3" with characters not less than ¼". They shall be made of two laminated black plastic sheets bonded with a middle sheet of white plastic and characters engraved in one black sheet to the depth of the white plastic. A typewritten list of Nameplates shall be submitted to the Design Professional for approval before ordering same.

3.10 EXPANSION OF PIPING:

- A. All piping connections shall be made so as to allow for perfect freedom of movement of piping during expansion and contraction, without springing or creating air pockets which will impair the flow of the water through the system. Install expansion loops as shown on the drawing or as required. Expansion loops shall be made with swing joints, bends or long offsets as necessary. Provide expansion guides.

3.11 ANCHORS AND GUIDES:

- A. Anchors shall be provided where shown and/or required for the proper control of stress in piping due to expansion.

3.12 ACCESS:

- A. All equipment requiring maintenance or adjustment must be accessible. Items located above ceilings shall be located above accessible portions of the ceiling or above access panels provided by this Contractor. Manufactured items with internal components requiring access (whether integral with the enclosure or not) shall be provided with access panels. Access panels shall be provided in ductwork where required for maintenance or adjustment of internal components.

3.13 CONCRETE HOUSEKEEPING PADS:

- A. Refer also to "Concrete" article in Part Two of this specification section.
- B. Concrete housekeeping pads shall be provided for all floor mounted mechanical equipment located in mechanical spaces. Where pads are shown on the drawings, they are representative only and do not necessarily indicate all locations where pads are required.
- C. Pads shall be not less than 6" above the floor and shall extend not less than 6" beyond the equipment base in all directions, unless otherwise noted on the drawings.
- D. Pads provided for air handling equipment shall be of sufficient height to allow for proper trap depth in the cooling coil condensate removal system.

3.14 SPARE FILTERS:

- A. For all equipment provided with filters, this contractor shall provide spare filters to be installed after final acceptance of the systems. It is the responsibility of this contractor to install spare filters.

3.15 FIRE STOPPING:

- A. All penetrations through fire-resistance-rated floor, fire resistance rated, floor/ceiling assemblies and roof construction and through fire-resistance-rated walls and partitions shall be fire stopped.
- B. Penetrations to be fire stopped include both empty openings and those containing cables, pipes, ducts, conduits, and any other items.
- C. Fire rating of sealed penetrations shall meet or exceed the rating of the assembly being penetrated.
- D. Materials shall be installed in accordance with manufacturer's recommendations and their UL listing.

3.16 PREPARATION FOR TESTING AND BALANCING:

- A. Review Contract Documents and submittals to verify that piping, instruments, thermowells, valves, ductwork, dampers, measurement and control devices, and access openings have been provided in correct quantity and at correct locations to permit testing and balancing of air and hydronic systems under various operating conditions.
- B. Provide V-belt drives or variable pitch sheaves for fans as indicated. Provide variable frequency drives as Work of Division 26. Replace variable pitch sheaves or initial fixed pitch sheaves with appropriate fixed pitch sheaves when correct speed (rpm) has been determined by Testing and Balancing Agency. Deliver variable-pitch sheaves and initial fixed pitch sheaves to Owner's Representative. Notify TAB Agency upon completion of sheave replacement.
- C. Inform TAB Agency regarding major deviations from Contract Documents made to systems during construction and furnish one (1) complete set of Record Drawings, showing presence and location of balancing elements, volume dampers, air extractors and instrument ports, prior to start of TAB work.
- D. Provide indicated Work and submit certification that each operation indicated is complete and in accordance with Contract Documents. Accomplish this Work before TAB work can start. Within 30 days of notification by Owner of award of Testing and Balancing Contract, submit schedule to complete following work:
  - 1. Complete physical installation.
  - 2. Pressure test air, and hydronic systems as required.
  - 3. Clean, flush, fill and chemically treat hydronic systems as required. Provide temporary start-up strainers and replace with clean strainers after system cleaning as indicated.
  - 4. Provide each air system with medium-efficiency disposable start-up filters. Replace filters one (1) time during construction. Replace with new specified filters upon acceptance of each system by Owner's Representative.
  - 5. Test and operate prime movers, including fans, at full design load to verify adequate power, proper rotation, completed controls, operational auxiliaries, and complete overall installation.
  - 6. Balance rotating equipment statically and dynamically.
  - 7. Secure linkages.
  - 8. Properly evacuate air from liquid systems. Install air vents at coils and at high points in systems whether or not expressly indicated and verify that they operate properly. Verify that expansion tanks are filled and in proper working order.
  - 9. Verify that automatic control valves are in proper working order and location, that they are marked and installed with correct "NORMAL" positions as required, and that hand valves and balancing valves are positioned for full flow through equipment.

10. Verify that automatic control dampers are in proper working order and location, that they are marked and installed with "NORMAL" positions as required. Verify that balancing and shut-off dampers are positioned for full flow. Verify that equipment, terminal devices and distribution systems are completely and properly connected.
- E. For each item of mechanical equipment, submit typed Data Register in non-yellowing, clear plastic binder, and securely attach it to associated equipment. Show operating temperature, pressure, flow rate, amperage, voltage, phase, frequency (Hz), rpm and brake horsepower {input power (kW), as appropriate.
- F. Deliver to TAB Agency, for use until TAB work is complete, flow-indicating devices intended for use with permanently installed primary flow measuring devices. Calibrate permanently installed flow measuring devices and associated display instruments, thermometers, sensors and pressure gauges. Deliver documentation to TAB Agency to verify calibrations.
- G. Submit schedule stating when each system is ready for TAB work to begin. Separate schedule by area, and mechanical system. Submit schedule within 30 days of Contract Award. Update schedule at least two (2) months in advance of scheduled start of TAB work.
- H. Attend coordination meetings between TAB Agency, and Owner's Representative, conducted under guidance of Contractor. First meeting is approximately two (2) weeks before scheduled start of TAB work, as scheduled by Mechanical Contractor and approved by Owner's Representative.
- I. Provide labor, material, tools and equipment to operate mechanical equipment and systems during TAB work, and for required adjustments, calibrations and repairs of automatic control devices or their components. Provide these services on each working day and without undue delay, as required by TAB Agency. Protect and operate equipment and systems during TAB work.
- J. When requested by TAB Agency, furnish services of personnel to accompany TAB Agency when TAB work is being performed.
- K. Make modifications at no additional cost and to satisfaction of Owner's Representative to rectify discrepancies reported by TAB Agency indicating non-compliance with Contract Documents.

END OF SECTION

SECTION 230005

COORDINATION DRAWING REQUIREMENTS FOR HVAC

PART 1 – GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 COORDINATION DRAWINGS

- A. All mechanical, electrical, plumbing, fire protection, telecommunications, and ATC subcontractors will be required to use AutoCad (CAD) format. Coordination drawings will be distributed via email and/or USB drive.

1.3 ABOVE CEILING AND NO CEILING OVERHEAD INSTALLATION

- A. The Mechanical Contractor shall furnish minimum 1/4" scale CAD electronic background drawings of the sheet-metal shop drawings, for incorporation of plumbing and mechanical piping services. All ductwork and piping systems shall be thoroughly dimensioned as to location and height above finished floor. Each different system will be drawn in a different color. Upon conclusion of the various systems coordination with the Sheet-Metal Contractor, the composite drawing shall be distributed by the Construction Manager for contractor coordination. All lighting fixture locations will be "ghosted in" by the Sheet-Metal Contractor for coordination of the same. The Sheet-Metal Contractor shall prepare a title box on each drawing which allows space for the signature of the authorized individual from the Sheet-Metal, HVAC Piping, Plumbing, Fire Protection, Electrical, Telecommunications and ATC firms, with the statement below:

"The undersigned individual certifies by their signature that they have coordinated their work with all other work noted on this drawing and the contract documents and shall be held responsible for any costs arising out of their respective inability to fully coordinate their work."

NOTE: The composite drawing is in addition to separate shop drawings to be submitted at the conclusion of the coordination process.

- B. At the conclusion of each composite drawing coordination process, the Construction Manager shall be notified by the Mechanical Contractor Project Manager. The Mechanical Contractor Project Manager shall then schedule an on-site coordination meeting for the purpose of signing off on the respective drawing. The Mechanical Contractor shall not be authorized to release any material for fabrication or installation until the composite drawing signature process is executed or until Construction Manager authorizes, in writing, a portion of the work to proceed.
- C. The Mechanical Contractor shall print a weekly status log and maintain a file for the project on this process. Each subcontractor is responsible to submit and coordinate their work with the Construction Manager and Mechanical Contractor.
- D. The Fire Protection Contractor shall overlay their complete piping system on a composite background drawing furnished by the Mechanical Contractor. The Fire Protection Contractor shall utilize a different color from that previously used by the HVAC and Plumbing draftsmen. The Fire Protection Contractor shall cooperate in the coordination process by the relocation of their piping as required to facilitate coordination. When completed, Sprinkler Contractor's

coordination drawing shall be delivered to the Construction Manager. At the conclusion of the entire coordination process, the Fire Protection Contractor shall be responsible for attending a coordination meeting at the jobsite for the purpose of their authorized personnel affixing their signatures to the statement below:

“The undersigned individual certifies by their signature that they have coordinated their work with all other work noted on this drawing and the contract documents and shall be held responsible for any costs arising out of their respective inability to fully coordinate their work.”

NOTE: The composite drawing is in addition to a separate sprinkler piping shop drawing to be submitted at the conclusion of the coordination process.

- E. The Electrical Contractor shall be responsible to overlay their major conduit racks and equipment, as well as verifying all lighting fixture locations and heights for coordination with the other trades on a composite drawing prepared by the Mechanical Contractor. All conduits larger than 2” shall be documented. When completed, Electrical Contractor’s coordination drawing shall be delivered to the Construction Manager. At the conclusion of the coordination drawing process, the Electrical Contractor shall be responsible to attend a coordination meeting at the jobsite for the purpose of their authorized personnel affixing their signature to the statement below:

“The undersigned individual certifies by their signature that they have coordinated their work with all other work noted on this drawing and the contract documents and shall be held responsible for any costs arising out of their respective inability to fully coordinate their work.”

- F. The Plumbing Contractor will be responsible to overlay their major piping racks and equipment, as well as verifying all plumbing fixture locations and heights for coordination with the other trades on a composite drawing prepared by the Mechanical Contractor. When completed, Plumbing Contractor’s coordination drawing shall be delivered to the Construction Manager. At the conclusion of the coordination drawing process, the Plumbing Contractor shall be responsible to attend a coordination meeting at the jobsite for the purpose of their authorized personnel affixing their signature to the statement below:

“The undersigned individual certifies by their signature that they have coordinated their work with all other work noted on this drawing and the contract documents and shall be held responsible for any costs arising out of their respective inability to fully coordinate their work.”

- G. The Telecommunication Contractor will be responsible to overlay their major communication racks and cable tray, as well as verifying locations and heights for coordination with the other trades on a composite drawing prepared by the Mechanical Contractor. When completed, Telecommunication Contractor’s coordination drawing shall be delivered to the Construction Manager. At the conclusion of the coordination drawing process, the Telecommunication Contractor shall be responsible to attend a coordination meeting at the jobsite for the purpose of their authorized personnel affixing their signature to the statement below:

“The undersigned individual certifies by their signature that they have coordinated their work with all other work noted on this drawing and the contract documents and shall be held responsible for any costs arising out of their respective inability to fully coordinate their work.”

- H. Provide survey and coordination of underground plumbing for verification of location.



- I. Drawings, if available, may be obtained electronically from the Architect through the Construction Manager.
- J. The Mechanical, Electrical, Plumbing, Fire Protection, Telecommunication and ATC Contractors shall receive hard copies of all drawings.
- K. The Mechanical, Electrical, Plumbing, Fire Protection, Telecommunication and ATC Contractors shall review all drawings and advise if any additional drawings are needed.
- L. The Mechanical Trade Contractor shall take the lead and develop a drawing list for submissions and a submission schedule coordinated with the construction activities. The drawings shall be developed in a sequential fashion so as to no delay installation of the work or the overall project schedule. The lead Mechanical trade contractor shall include a master key plan so that the area of each drawing can be readily identified as to the location within each building. The Plumbing trade contractor shall lead the underground coordination and the HVAC trade contractor shall lead the balance of the coordination work. The drawing list and schedule shall be forwarded to the Construction Manager for review.
- M. Pursuant to Construction Manager approval of the list and schedule, the Mechanical trade contractor shall provide to all participants the latest plans in a timely fashion in accordance with their schedule.
- N. Prior to the start of the work, each subcontractor shall forward an insulation schedule to the Construction Manager M.E.P. Coordinator. The schedule shall show the size and thickness of each type of insulation and its intended use.

#### 1.4 SHEET-METAL / PIPING / ATC / ELECTRICAL ACCESS / MAINTENANCE CLEARANCES

- A. As soon as practical, the Mechanical trade contractor shall prepare layout drawings (not less than 1/4" scale) of all ductwork and piping. These drawings shall show all WALL FIRE RATINGS, registers, grilles, diffusers and similar features, as well as locations of all valves, dampers, damper operators and other items requiring access for maintenance. It shall also be the responsibility of the Mechanical trade contractor to show on these drawings; beams with bottom elevations, ceiling heights, wall-to-wall dimensions, partitions, columns, windows, doors, electric lighting layouts as shown on the reflected ceiling plans, acoustical ceiling grid, and other major architectural and structural features as shown on the General Construction Drawings. All dimensions should be from centerlines of columns. All required access to equipment for service and/or required for NEC code required clearances shall be shown in a dotted zone.
- B. The Mechanical trade contractor, upon completion of their work, shall email their data back to the Plumbing trade contractor and copy all participants. The Plumbing trade contractor shall download the mechanical data and incorporate, by separate layer, their own routing, as well as other areas requiring access for service and maintenance to determine their relationship and possible interferences with the mechanical, architectural, or structural features to be performed as part of the work.
- C. The Plumbing trade contractor shall then email their data to the Electrical trade contractor and copy all participants. The Electrical trade contractor shall download the drawing and incorporate, by separate layer, their own routings, as well as the depth of all light fixtures, access panels, etc., as required to determine the relationship and possible interferences with plumbing, mechanical, architectural, or structural items to be installed as part of the overall work. The Electrical trade contractor shall be responsible to verify that the electrical lighting layout shown on these drawings is correct and to make corrections and additions of all other light fixtures as required. In areas where no mechanical work occurs, but where other crowded electrical installations are evident, the Electrical trade contractor shall prepare similar drawings.

- D. The Electrical trade contractor shall then email the Fire Protection trade contractor and copy all participants. The Fire Protection trade contractor shall download the drawing and incorporate, by separate layer, their own routings, as well as other areas requiring access for service and maintenance, to determine their relationship and possible interferences with the mechanical, electrical, plumbing, and architectural or structural items to be installed as part of the overall work.
- E. The Mechanical trade contractor shall provide one composite set of reproducible drawings and forward them to the Construction Manager. This composite shall then be reviewed during meetings determined by the Construction Manager, at which all subcontractors including their subcontractors, as required by the Construction Manager, shall be represented to review and resolve any real or apparent interference or conflicts.
- F. In the preparation of all the final composite drawings, large scale details, as well as cross and longitudinal sections shall be made as required to fully delineate all conditions. Particular attention shall be given to the locations, size and clearance dimensions of equipment items, shafts and similar features. The final composite drawings shall include the locations of all controls, tie-ins, connections for other subcontractor's work, and pipe and duct insulation as required.
- G. Final composite drawings shall then be signed off by each trade subcontractor indicating their acceptance and approval of the indicated routings and layouts and their relationship with the adjoining or contiguous work of all subcontracts. Thereafter, no unauthorized deviations shall be permitted. If deviations are made without the knowledge and agreement of Construction Manager and other affected trade contractors, the work in question shall be subject to removal and correction at no additional cost.
- H. In preparing the composite drawings, minor changes in duct, pipe or conduit routings that do not affect the intended function may be made as required to avoid space conflicts, when mutually agreed. Items may not be resized, exposed items relocated, or items run exposed when not intended, without approval. No changes shall be made in any structural members or architectural features which affect the function or aesthetics of the buildings. If conflicts or interferences cannot be satisfactorily resolved, the Engineer shall be notified, and their decision obtained.
- I. After final composite drawings have been accepted and approved, and signed by ALL subcontractors, the Mechanical trade contractor shall provide and distribute to each of the subcontractor and to Construction Manager. Subcontractors requiring further prints for their own distribution will accomplish same.
- J. The record copies of final composite drawings shall be retained by each subcontractor as a working reference. All shop drawings, prior to their submittal to Construction Manager, shall be compared with the composite drawings and developed accordingly by the subcontractor responsible. Any revisions to the composite drawings, which may become necessary during the process of the work, shall be noted by all subcontractors and shall be neatly and accurately recorded on the record copies. Each trade contractor shall be responsible for the up-to-date maintenance of their own record copies of the composite drawings and to keep one copy available at the site. The composite drawings and any subsequent changes thereto, shall be utilized by each subcontractor in the development of their as-built drawings. NOTE: The coordination drawings may be used with appropriate changes as as-builts and changes to title block.
- K. Preparation of coordination drawings shall commence as soon as possible after award of the subcontract. The coordination drawings may lack complete data in certain instances pending receipt of equipment drawings, but sufficient space shall be allotted for the items affected. When final information is received, such data shall be promptly inserted on the composite by that trade contractor.

- L. Coordination is the responsibility of all trade contractors. Construction Manager will call meetings, weekly, or as required, which subcontractors must attend to avoid delay. Failure to attend shall require the trade contractor to field run the work not coordinated. No extra compensation will be paid to any trade contractor for relocating any duct, pipe, conduit or other material that has been installed without proper coordination. If the installation of any uncoordinated work or improper installation or coordinated work necessitates additional work by other subcontractors, at the cost of such additional work shall be assigned to the trade contractor responsible as determined by Construction Manager.
- M. All changes in the work of any subcontract shall be shown on the composite drawings.
- N. All work on the coordination composite drawings shall be performed by competent CAD operators, in a clear legible manner. Each trade contractor shall execute a typical drawing activity in no more than three working days. It shall be the responsibility of each subcontractor to supply a sufficient number of CAD operators so as not to delay the coordination process. Construction Manager and Engineer shall be the judge of the acceptability of the drawings.
- O. The composite drawings shall not be used for as-built drawings. (See Paragraph above)
- P. It shall be further understood that each trade contractor's specified submittals shall be transmitted for approval during the coordination period in order that the project encounter no delays.
- Q. The Mechanical trade subcontractor shall pre-coordinate all control equipment locations with the designated ATC trade subcontractor and indicate it on the composite document.

#### 1.5 REQUIREMENTS

- A. All Mechanical, Electrical, Plumbing, Fire Protection, Telecommunication and ATC trade contractors shall be required to use AutoCad (CAD) format. Coordination drawings shall be distributed via email or USB drive. ALL EMAILS SHALL BE COPIED TO CONSTRUCTION MANAGER, ENGINEER, AND PROJECT MANAGER.
- B. The Sheet-Metal trade contractor shall prepare a title box on each drawing which allows space for the signature of the authorized individual from the sheet-metal, HVAC, piping, plumbing, sprinkler, electrical and ATC firms with the statement below:

"The undersigned individual certifies by their signature that they have coordinated their work with all other work noted on this drawing and the contract documents and shall be held responsible for any costs arising out of their respective inability to fully coordinate their work."
- C. The Mechanical trade contractor shall not be authorized to release any material for fabrication or installation until the composite drawing signature process is executed or until Construction Manager authorizes, in writing, a portion of the work to proceed.
- D. The Mechanical Contractor shall print a weekly status of all emails sent and received and maintain a hard copy file for use at the coordination "sign-off" meetings. Each subcontractor is required to check emails daily.
- E. Submittals: Once the coordination process has been completed, the coordination drawings shall be submitted to the Engineer for review. A single-color plot, as well as three blueprint copies of the drawings shall be submitted for review. The color plot shall delineate between the various disciplines by utilizing different color pens for each system.

#### PART 2 – PRODUCTS (NOT APPLICABLE)

PART 3 – EXECUTION (NOT APPLICABLE)

END OF SECTION

## SECTION 230513

### COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

##### 1.4 ACTION SUBMITTALS

- A. Product Data:
  - 1. Provide nameplate data including manufacturer, model, service factor, frame size, rpm, HP, voltage, phase, frequency, NEMA enclosure type, full load amperes, Design and Code letters, and insulation class.
  - 2. Provide NEMA nominal and guaranteed minimum efficiencies and power factor at full load, weights and dimensions, UL listing where applicable, and bearing L10 life.
  - 3. Certified sound-power ratings.
- B. Wiring Diagrams: For power, signal, and control wiring.

##### 1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

##### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For centrifugal fans to include in operation, and maintenance manuals.

##### 1.7 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
  - 1. Motor controllers.
  - 2. Torque, speed, and horsepower requirements of the load.
  - 3. Ratings and characteristics of supply circuit and required control sequence.
  - 4. Ambient and environmental conditions of installation location.

## PART 2 - PRODUCTS

### 2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Comply with IEEE 841 for severe-duty motors.
- C. Motors 1 hp and larger shall be premium efficiency.
- D. Motors on equipment located outdoors shall be totally-enclosed, fan-cooled (TEFC) type. Motors on equipment located indoors shall be open drip-proof (ODP) or TEFC type unless otherwise noted.
- E. Motors and drives shall not produce sound levels exceeding 90 dBA in accordance with Subpart G, Occupational Noise Exposure, of OSHA Standards. Sound measurement data shall be obtained in accordance with IEEE 85. Noise levels exceeding specified limit shall be clearly stated in Submittals.
- F. Two-speed motors shall include separate windings.
- G. 120 volt motors less than 1 hp shall include integral thermal overload protection with manual reset. If an integral overload is not available, format a motor rated toggle switch with thermal overload and provide to the electrical contractor for installation by electrical contractor.
- H. Provide thermostats for hazardous duty and inverter duty motors, where required for warranty, to prevent overheating. Thermostat settings shall be 80 percent of temperature rating.
- I. Motors 10 hp and higher shall include power factor correction to 95 percent, using either factory-installed and wired capacitors, or separately mounted and field-wired capacitors. Capacitors shall be UL-listed, non-PCB with self-healing dielectric film, pressure-sensitive interrupter, discharge resistors, grounding lug, and current-limiting protective fuses. Capacitors shall have 20-year nominal life, two (2) year special warranty, and shall be General Electric-Aerovox, Sprague, ABB, or Versatex. If correction devices are not so furnished, it shall be the responsibility of the Contractor furnishing the equipment to pay all wiring and installation costs.
- J. For VFD motors, provide shaft mounted static discharge dissipation ring with conductive microfibers (Electro Static Technology AEGIS SGR or approved equal) to shunt bearing currents or provide electrically insulated ceramic bearings.
- K. Motor Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. General Electric.
  - 2. MagneTek.
  - 3. Marathon.
  - 4. Reliance.
  - 5. Emerson Motors.
  - 6. Baldor.
  - 7. Toshiba.
- L. Motor Base Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Korfund Dynamics Corp.

2. Mason Industries, Inc.
3. Consolidated Kinetics Corp.

## 2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

## 2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
  1. For motors with 2:1 speed ratio, consequent pole, single winding.
  2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Re-greaseable, shielded, antifriction ball bearings suitable for radial and thrust loading. Bearings for 460-volt motors: shielded, re-greaseable, vacuum degassed steel ball bearings sized for a minimum life (L-10) of 100,000 hours. Bearing housings shall be large enough to hold sufficient lubricant to minimize need for frequent lubrication. Provide extended grease tubes suitable for regreasing bearings in service.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F.
- J. Code Letter Designation:
  1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
  2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

## 2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

## 2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

## 2.6 MOTOR DRIVE AND BASES

A. Provide motors with Type A, B, C or D matched set V-belt drives or direct drives as indicated.

1. Drives shall be designed for 150 percent of specified motor nameplate horsepower rating.
2. Provide V-belts of endless cord impregnated rubber of trapezoidal cross-section.
3. Provide adjustable screw device for belt tensioning.
4. Drives shall include minimum of two (2) belts.

B. Provide variable-pitch motor sheaves for fans and other belt-driven equipment under 25 hp. Provide fixed-pitch "initial" motor sheaves for fans and other belt-driven equipment 25 hp and larger. Deliver variable and fixed pitch sheaves to Owner's Representative.

## 2.7 BELTS AND COUPLING GUARDS

A. Provide easily removable guards to completely enclose all V-belt drives, pulleys, sheaves and couplings.

B. Guards shall comply with requirements of Subpart O (Machinery and Machine Guarding) of referenced OSHA Standards.

C. Tachometers shall be readable with guards in place.



- D. Where grease fittings are enclosed by guards, provide grease fitting extensions to accessible location outside of guard.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install Work in accordance with manufacturer's written instructions.
- B. When not installed with driven equipment on a common base, install and align motors and drives.
- C. Provide field wiring where separately mounted motor capacitors are used.
- D. Provide control wiring from motor thermostats for hazardous duty and inverter duty motors to starter control circuit.

#### 3.2 FIELD QUALITY CONTROL

- A. Visually inspect motors for correct mounting, grounding, power connections and lubrication. Verify that thermostats, RTDs, and other auxiliaries are connected.
- B. Megger test each 460-volt motor 40 hp and above using a 500 V dc test voltage and record the results. Minimum acceptable insulation resistance is 100 megohms. Test duration shall be one (1) minute except motors 200 hp and above shall be tested for ten (10) minutes. Calculate polarization index. Minimum acceptable polarization index is 2.0. Report and correct irregularities immediately.
- C. Furnish calibrated instruments for testing motors.
- D. Perform rotation test for proper shaft direction.
- E. Prepare test and inspection reports.

END OF SECTION

## SECTION 230517

### SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section Includes:
  - 1. Sleeves.
  - 2. Sleeve-seal systems.
  - 3. Sleeve-seal fittings.
  - 4. Grout.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

#### PART 2 - PRODUCTS

##### 2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral water-stop unless otherwise indicated.
- B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

##### 2.2 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Advance Products & Systems, Inc.
  - 2. CALPICO, Inc.
  - 3. Metraflex Company (The).
  - 4. Pipeline Seal and Insulator, Inc.
  - 5. Proco Products, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

### 2.3 SLEEVE-SEAL FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  1. HOLDRITE.
- B. Description: Manufactured plastic, sleeve-type, water-stop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber water-stop collar with center opening to match piping OD.

### 2.4 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Non-shrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## PART 3 - EXECUTION

### 3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
  1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, roof decks and concrete walls as new slabs and walls are constructed.
  1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
  2. Cut sleeves to length for mounting flush with both surfaces.
    - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
  3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
  1. Cut sleeves to length for mounting flush with both surfaces.

2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
  3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

### 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

### 3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water-stop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

### 3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
  1. Exterior Concrete Walls above Grade:
    - a. Piping Smaller Than NPS 4: Galvanized-steel-pipe sleeves.
    - b. Piping NPS 4 and Larger: Galvanized-steel-pipe sleeves.
  2. Concrete Slabs above Grade:
    - a. Piping Smaller Than NPS 4: Galvanized-steel-pipe sleeves.
    - b. Piping NPS 4 and Larger: Galvanized-steel-pipe sleeves.
  3. Concrete Slabs above Grade (Mechanical equipment areas or other wet areas):
    - a. Piping Smaller Than NPS 4: Galvanized-steel-pipe sleeves with sleeve-seal fittings.
    - b. Piping NPS 4 and Larger: Galvanized-steel-pipe sleeves with sleeve-seal system.
  4. Interior Partitions:
    - a. Piping Smaller Than NPS 4: Carbon-steel-pipe sleeves.

- b. Piping NPS 4 and Larger: Carbon-steel-pipe sleeves.

END OF SECTION

## SECTION 230518

### ESCUTCHEONS FOR HVAC PIPING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section Includes:
  - 1. Escutcheons.
  - 2. Floor plates.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

#### PART 2 - PRODUCTS

##### 2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

##### 2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

#### PART 3 - EXECUTION

##### 3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:
  - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
  - b. Insulated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
  - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
  - d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
  - e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
  - f. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.

### 3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION

## SECTION 230529

### HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fastener systems.

- B. Related Sections:

1. Section 230548 "Vibration Controls for HVAC" for vibration isolation devices.
2. Section 233113 "Metal Ducts" for duct hangers and supports.

##### 1.4 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

##### 1.5 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
  1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
  2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

##### 1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:



1. Trapeze pipe hangers.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Detail fabrication and assembly of trapeze hangers.
  2. Design Calculations: Calculate requirements for designing trapeze hangers.

#### 1.7 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

#### 1.8 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

### PART 2 - PRODUCTS

#### 2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
  2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
  3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
  4. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Copper Pipe Hangers:
1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
  2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

#### 2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

#### 2.3 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

## 2.4 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
  - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.

## PART 3 - EXECUTION

### 3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
  - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
  - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Fastener System Installation:
  - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
  - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- E. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- F. Install lateral bracing with pipe hangers and supports to prevent swaying.
- G. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- H. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

### 3.2 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

### 3.3 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

### 3.4 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

### 3.5 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- G. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
  - 2. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
  - 3. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8.
  - 4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
  - 5. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
  - 6. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
  - 7. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
  - 8. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
  - 9. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
  - 10. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
  - 11. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
  - 12. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
  - 13. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
  - 14. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
  - 15. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
  - 16. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
  - 17. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
  - 18. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- H. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- I. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
  3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
  4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- J. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  6. C-Clamps (MSS Type 23): For structural shapes.
  7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
  8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
  9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
  10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
  11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
  12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): 750 lb.
    - b. Medium (MSS Type 32): 1500 lb.
    - c. Heavy (MSS Type 33): 3000 lb.
  13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
  15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
  2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
  3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.

4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
  5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
  6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
  7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
  8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    - a. Horizontal (MSS Type 54): Mounted horizontally.
    - b. Vertical (MSS Type 55): Mounted vertically.
    - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- L. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- M. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

## SECTION 230548

### VIBRATION CONTROLS FOR HVAC

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section Includes:
  - 1. Elastomeric isolation pads.
  - 2. Elastomeric isolation mounts.
  - 3. Restrained elastomeric isolation mounts.
  - 4. Open-spring isolators.
  - 5. Housed-spring isolators.
  - 6. Restrained-spring isolators.
  - 7. Housed-restrained-spring isolators.
  - 8. Pipe-riser resilient supports.
  - 9. Resilient pipe guides.
  - 10. Air-spring isolators.
  - 11. Restrained-air-spring isolators.
  - 12. Elastomeric hangers.
  - 13. Spring hangers.
  - 14. Vibration isolation equipment bases.
  - 15. Restrained isolation roof-curb rails.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
  - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.
- B. Shop Drawings:
  - 1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
  - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

- C. Delegated-Design Submittal: For each vibration isolation device.
  - 1. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For testing agency.
- C. Welding certificates.
- D. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent agency.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For [air-spring mounts] [and] [restrained-air-spring mounts] to include in operation and maintenance manuals.

#### 1.7 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

### PART 2 - PRODUCTS

#### 2.1 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Ace Mountings Co., Inc.
    - b. California Dynamics Corporation.
    - c. Isolation Technology, Inc.
    - d. Kinetics Noise Control, Inc.
    - e. Mason Industries, Inc.
    - f. Vibration Eliminator Co., Inc.
    - g. Vibration Isolation.
    - h. Vibration Mountings & Controls, Inc.
  - 2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
  - 3. Size: Factory or field cut to match requirements of supported equipment.
  - 4. Pad Material: Oil and water resistant with elastomeric properties.
  - 5. Surface Pattern: Waffle pattern.
  - 6. Infused nonwoven cotton or synthetic fibers.
  - 7. Load-bearing metal plates adhered to pads.
  - 8. Sandwich-Core Material: Resilient AND elastomeric.



- a. Surface Pattern: Waffle pattern.
- b. Infused nonwoven cotton or synthetic fibers.

## 2.2 ELASTOMERIC ISOLATION MOUNTS

### A. Double-Deflection, Elastomeric Isolation Mounts:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ace Mountings Co., Inc.
  - b. California Dynamics Corporation.
  - c. Isolation Technology, Inc.
  - d. Kinetics Noise Control, Inc.
  - e. Mason Industries, Inc.
  - f. Vibration Eliminator Co., Inc.
  - g. Vibration Isolation.
  - h. Vibration Mountings & Controls, Inc.
- 2. Mounting Plates:
  - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
  - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
- 3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.3 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

### A. Restrained Elastomeric Isolation Mounts:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ace Mountings Co., Inc.
  - b. California Dynamics Corporation.
  - c. Isolation Technology, Inc.
  - d. Kinetics Noise Control, Inc.
  - e. Mason Industries, Inc.
  - f. Vibration Eliminator Co., Inc.
  - g. Vibration Isolation.
  - h. Vibration Mountings & Controls, Inc.
- 2. Description: All-directional isolator with restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
  - a. Housing: Cast-ductile iron or welded steel.
  - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.4 OPEN-SPRING ISOLATORS

### A. Freestanding, Laterally Stable, Open-Spring Isolators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ace Mountings Co., Inc.
  - b. California Dynamics Corporation.
  - c. Isolation Technology, Inc.
  - d. Kinetics Noise Control, Inc.
  - e. Mason Industries, Inc.
  - f. Vibration Eliminator Co., Inc.
  - g. Vibration Isolation.
  - h. Vibration Mountings & Controls, Inc.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

## 2.5 HOUSED-SPRING ISOLATORS

### A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ace Mountings Co., Inc.
  - b. California Dynamics Corporation.
  - c. Isolation Technology, Inc.
  - d. Kinetics Noise Control, Inc.
  - e. Mason Industries, Inc.
  - f. Vibration Eliminator Co., Inc.
  - g. Vibration Isolation.
  - h. Vibration Mountings & Controls, Inc.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
  - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.

- b. Top housing with threaded mounting holes and internal leveling device elastomeric pad.

## 2.6 RESTRAINED-SPRING ISOLATORS

### A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ace Mountings Co., Inc.
  - b. California Dynamics Corporation.
  - c. Isolation Technology, Inc.
  - d. Kinetics Noise Control, Inc.
  - e. Mason Industries, Inc.
  - f. Vibration Eliminator Co., Inc.
  - g. Vibration Isolation.
  - h. Vibration Mountings & Controls, Inc.
2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
  - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
  - b. Top plate with threaded mounting holes elastomeric pad.
  - c. Internal leveling bolt that acts as blocking during installation.
3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

## 2.7 HOUSED-RESTRAINED-SPRING ISOLATORS

### A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ace Mountings Co., Inc.
  - b. California Dynamics Corporation.
  - c. Isolation Technology, Inc.
  - d. Kinetics Noise Control, Inc.
  - e. Mason Industries, Inc.
  - f. Vibration Eliminator Co., Inc.
  - g. Vibration Isolation.
  - h. Vibration Mountings & Controls, Inc.
2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.

- a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
  - b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
- 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

## 2.8 PIPE-RISER RESILIENT SUPPORT

- A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch-thick neoprene.
  - 1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
  - 2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

## 2.9 RESILIENT PIPE GUIDES

- A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch-thick neoprene:
  - 1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

## 2.10 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Ace Mountings Co., Inc.
    - b. California Dynamics Corporation.
    - c. Isolation Technology, Inc.
    - d. Kinetics Noise Control, Inc.
    - e. Mason Industries, Inc.
    - f. Vibration Eliminator Co., Inc.
    - g. Vibration Mountings & Controls, Inc.
  - 2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
  - 3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

## 2.11 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Ace Mountings Co., Inc.
    - b. California Dynamics Corporation.
    - c. Kinetics Noise Control, Inc.
    - d. Mason Industries, Inc.
    - e. Vibration Eliminator Co., Inc.
    - f. Vibration Isolation.
    - g. Vibration Mountings & Controls, Inc.
  2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
  3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
  8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
  9. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

## 2.12 VIBRATION ISOLATION EQUIPMENT BASES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. California Dynamics Corporation.
  2. Kinetics Noise Control, Inc.
  3. Mason Industries, Inc.
  4. Vibration Eliminator Co., Inc.
  5. Vibration Isolation.
  6. Vibration Mountings & Controls, Inc.
- B. Steel Rails: Factory-fabricated, welded, structural-steel rails.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.
    - a. Include supports for suction and discharge elbows for pumps.
  2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Rails shall have shape to accommodate supported equipment.
  3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

- C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.
  - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
    - a. Include supports for suction and discharge elbows for pumps.
  - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
  - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

## 2.13 RESTRAINED ISOLATION ROOF-CURB RAILS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Ace Mountings Co., Inc.
  - 2. California Dynamics Corporation.
  - 3. Kinetics Noise Control, Inc.
  - 4. Mason Industries, Inc.
  - 5. Thybar Corporation.
- B. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment.
- C. Upper Frame: Upper frame shall provide continuous and captive support for equipment.
- D. Lower Support Assembly: The lower support assembly shall be formed sheet metal section containing adjustable and removable steel springs that support upper frame. The lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials and shall be insulated with a minimum of 2 inches of rigid glass-fiber insulation on inside of assembly. Adjustable, restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
- E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.
- F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 VIBRATION CONTROL DEVICE INSTALLATION

A. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

END OF SECTION

## SECTION 230553

### IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section Includes:

- 1. Equipment labels.
- 2. Pipe labels.
- 3. Duct labels.
- 4. Stencils.
- 5. Valve tags.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

#### PART 2 - PRODUCTS

##### 2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brady Corporation.
  - b. Brimar Industries, Inc.
  - c. Carlton Industries, LP.
  - d. Champion America.
  - e. Craftmark Pipe Markers.



- f. emedco.
  - g. Kolbi Pipe Marker Co.
  - h. LEM Products Inc.
  - i. Marking Services, Inc.
  - j. Seton Identification Products.
2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
  3. Letter Color: Black.
  4. Background Color: White.
  5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
  6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
  7. Minimum Letter Size: 1/2 inch. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
  8. Fasteners: Stainless-steel self-tapping screws.
  9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## 2.2 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
  2. Brady Corporation.
  3. Brimar Industries, Inc.
  4. Carlton Industries, LP.
  5. Champion America.
  6. Craftmark Pipe Markers.
  7. emedco.
  8. Kolbi Pipe Marker Co.
  9. LEM Products Inc.
  10. Marking Services Inc.
  11. Seton Identification Products.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
  - 2. Lettering Size: At least 1/2 inch.

## 2.3 DUCT LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Brady Corporation.
  - 2. Brimar Industries, Inc.
  - 3. Carlton Industries, LP.
  - 4. Champion America.
  - 5. Craftmark Pipe Markers.
  - 6. emedco.
  - 7. Kolbi Pipe Marker Co.
  - 8. LEM Products Inc.
  - 9. Marking Services Inc.
  - 10. Seton Identification Products.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- C. Letter Color: Black
- D. Background Color: Blue.
- E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- H. Fasteners: Stainless-steel self-tapping screws.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- J. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

## 2.4 VALVE TAGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
  2. Brady Corporation.
  3. Brimar Industries, Inc.
  4. Carlton Industries, LP.
  5. Champion America.
  6. Craftmark Pipe Markers.
  7. emedco.
  8. Kolbi Pipe Marker Co.
  9. LEM Products Inc.
  10. Marking Services Inc.
  11. Seton Identification Products.
- B. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
  2. Fasteners: Brass wire-link chain or beaded chain.
- C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

### 3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

### 3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

### 3.4 PIPE LABEL INSTALLATION

- A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts and plenums; and exterior exposed locations as follows:
  - 1. Near each valve and control device.
  - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  - 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
  - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
  - 5. Near major equipment items and other points of origination and termination.
  - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
  - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- C. Pipe Label Color Schedule:
  - 1. Natural Gas Piping: White letters on a safety-yellow background.
  - 2. Refrigerant Piping: White letters on a safety-black background.

### 3.5 DUCT LABEL INSTALLATION

- A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
  - 1. Blue: For cold-air supply ducts.
  - 2. Green: For exhaust-, outside, relief and return.
- B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

### 3.6 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
  - 1. Valve-Tag Size and Shape:
    - a. Refrigerant: 2 inches, round.
    - b. Gas: 2 inches, round.

END OF SECTION

## SECTION 230593

### TESTING, ADJUSTING, AND BALANCING FOR HVAC

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section Includes:
  - 1. Balancing Air Systems:
    - a. Constant-volume air systems.
    - b. Variable-air-volume systems.
  - 2. Testing, Adjusting, and Balancing Equipment:
    - a. Motors.
    - b. Heat-transfer coils.
  - 3. Duct leakage tests.
  - 4. Control system verification.

##### 1.4 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. BAS: Building automation systems.
- C. TAB: Testing, adjusting, and balancing.
- D. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- E. TDH: Total dynamic head.

##### 1.5 PREINSTALLATION MEETINGS

- A. TAB Conference: Conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.
  - 1. Minimum Agenda Items:
    - a. The Contract Documents examination report.

- b. The TAB plan.
- c. Needs for coordination and cooperation of trades and subcontractors.
- d. Proposed procedures for documentation and communication flow.

## 1.6 ACTION SUBMITTALS

### A. LEED Submittals:

- 1. Air-Balance Report for Prerequisite IEQ 1: Documentation indicating that work complies with ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- 2. TAB Report for Prerequisite EA 2: Documentation indicating that work complies with ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

## 1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB reports.
- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
  - 1. Instrument type and make.
  - 2. Serial number.
  - 3. Application.
  - 4. Dates of use.
  - 5. Dates of calibration.

## 1.8 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Certified by AABC.
  - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
  - 2. TAB Technician: Employee of the TAB specialist and certified by AABC as a TAB technician.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

#### 1.9 FIELD CONDITIONS

- A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

### PART 2 - PRODUCTS (NOT APPLICABLE)

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan curves.
  - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
  - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible, and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
- L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine operating safety interlocks and controls on HVAC equipment.
- O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

### 3.2 PREPARATION

- A. Prepare a TAB plan that includes the following:
  - 1. Equipment and systems to be tested.
  - 2. Strategies and step-by-step procedures for balancing the systems.
  - 3. Instrumentation to be used.
  - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
  - 1. Airside:
    - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
    - b. Duct systems are complete with terminals installed.
    - c. Volume, smoke, and fire dampers are open and functional.
    - d. Clean filters are installed.
    - e. Fans are operating, free of vibration, and rotating in correct direction.
    - f. Variable-frequency controllers' startup is complete, and safeties are verified.
    - g. Automatic temperature-control systems are operational.
    - h. Ceilings are installed.
    - i. Windows and doors are installed.
    - j. Suitable access to balancing devices and equipment is provided.

### 3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
  - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.



2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
  3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

### 3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

### 3.5 PROCEDURES FOR CONSTANT VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
  1. Measure total airflow.
    - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
    - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

- d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
2. Measure fan static pressures as follows:
    - a. Measure static pressure directly at the fan outlet or through the flexible connection.
    - b. Measure static pressure directly at the fan inlet or through the flexible connection.
    - c. Measure static pressure across each component that makes up the air-handling system.
    - d. Report artificial loading of filters at the time static pressures are measured.
  3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
  4. Obtain approval from Engineer of Record for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
  5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
1. Measure airflow of submain and branch ducts.
  2. Adjust submain and branch duct volume dampers for specified airflow.
  3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
  2. Measure inlets and outlets airflow.
  3. Adjust each inlet and outlet for specified airflow.
  4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.
1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
  2. Re-measure and confirm that total airflow is within design.
  3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
  4. Mark all final settings.
  5. Test system in economizer mode. Verify proper operation and adjust if necessary.
  6. Measure and record all operating data.
  7. Record final fan-performance data.
- ### 3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS
- A. Adjust the variable-air-volume systems as follows:
1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.

2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
  - a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
  - b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
  - c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
  - d. Adjust controls so that terminal is calling for minimum airflow.
  - e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
  - f. When in full cooling or full heating, ensure that there is no mixing of hot-deck and cold-deck airstreams unless so designed.
  - g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
  - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
  - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
  - c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
  - d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
  - e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
6. Measure fan static pressures as follows:
  - a. Measure static pressure directly at the fan outlet or through the flexible connection.
  - b. Measure static pressure directly at the fan inlet or through the flexible connection.
  - c. Measure static pressure across each component that makes up the air-handling system.
  - d. Report any artificial loading of filters at the time static pressures are measured.
7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
  - a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
  - b. Verify that terminal units are meeting design airflow under system maximum flow.

8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:
  - a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
  - b. Re-measure and confirm that total airflow is within design.
  - c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
  - d. Mark final settings.
  - e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
  - f. Verify tracking between supply and return fans.

### 3.7 PROCEDURES FOR MOTORS

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
  1. Manufacturer's name, model number, and serial number.
  2. Motor horsepower rating.
  3. Motor rpm.
  4. Phase and hertz.
  5. Nameplate and measured voltage, each phase.
  6. Nameplate and measured amperage, each phase.
  7. Starter size and thermal-protection-element rating.
  8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

### 3.8 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record fan and motor operating data.

### 3.9 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each refrigerant coil:
  1. Dry-bulb temperature of entering and leaving air.
  2. Wet-bulb temperature of entering and leaving air.
  3. Airflow.

### 3.10 DUCT LEAKAGE TESTS

- A. Witness the duct pressure testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified tolerances.
- C. Report deficiencies observed.

### 3.11 CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:
  - 1. Verify temperature control system is operating within the design limitations.
  - 2. Confirm that the sequences of operation are in compliance with Contract Documents.
  - 3. Verify that controllers are calibrated and function as intended.
  - 4. Verify that controller set points are as indicated.
  - 5. Verify the operation of lockout or interlock systems.
  - 6. Verify the operation of valve and damper actuators.
  - 7. Verify that controlled devices are properly installed and connected to correct controller.
  - 8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
  - 9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.
- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

### 3.12 TOLERANCES

- A. Set HVAC system's airflow rates within the following tolerances:
  - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus, or minus 10 percent.
  - 2. Air Outlets and Inlets: Plus, or minus 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

### 3.13 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

### 3.14 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
  - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
  - 2. Include a list of instruments used for procedures, along with proof of calibration.
  - 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:

1. Fan curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
  - a. Indicated versus final performance.
  - b. Notable characteristics of systems.
  - c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans performance forms including the following:
  - a. Settings for outdoor, return, and exhaust air dampers.
  - b. Conditions of filters.
  - c. Cooling coil, wet- and dry-bulb conditions.
  - d. Face and bypass damper settings at coils.
  - e. Fan drive settings including settings and percentage of maximum pitch diameter.
  - f. Settings for supply-air, static-pressure controller.
  - g. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Duct, outlet, and inlet sizes.
3. Pipe and valve sizes and locations.
4. Terminal units.
5. Balancing stations.
6. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:
  - a. Unit identification.
  - b. Location.

- c. Make and type.
  - d. Model number and unit size.
  - e. Manufacturer's serial number.
  - f. Unit arrangement and class.
  - g. Discharge arrangement.
  - h. Sheave make, size in inches, and bore.
  - i. Center-to-center dimensions of sheave and amount of adjustments in inches.
  - j. Number, make, and size of belts.
  - k. Number, type, and size of filters.
2. Motor Data:
- a. Motor make, and frame type and size.
  - b. Horsepower and rpm.
  - c. Volts, phase, and hertz.
  - d. Full-load amperage and service factor.
  - e. Sheave make, size in inches, and bore.
  - f. Center-to-center dimensions of sheave and amount of adjustments in inches.
3. Test Data (Indicated and Actual Values):
- a. Total airflow rate in cfm.
  - b. Total system static pressure in inches wg.
  - c. Fan rpm.
  - d. Discharge static pressure in inches wg.
  - e. Filter static-pressure differential in inches wg.
  - f. Cooling-coil static-pressure differential in inches wg.
  - g. Heating-coil static-pressure differential in inches wg.
  - h. Outdoor airflow in cfm.
  - i. Return airflow in cfm.
  - j. Outdoor-air damper position.
  - k. Return-air damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:
- a. System identification.
  - b. Location.
  - c. Coil type.
  - d. Number of rows.
  - e. Fin spacing in fins per inch o.c.
  - f. Make and model number.
  - g. Face area in sq. ft.
  - h. Tube size in NPS.
  - i. Tube and fin materials.
  - j. Circuiting arrangement.
2. Test Data (Indicated and Actual Values):
- a. Airflow rate in cfm.
  - b. Average face velocity in fpm.
  - c. Air pressure drop in inches wg.
  - d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
  - e. Return-air, wet- and dry-bulb temperatures in deg F.

- f. Entering-air, wet- and dry-bulb temperatures in deg F.
- g. Leaving-air, wet- and dry-bulb temperatures in deg F.
- h. Refrigerant expansion valve and refrigerant types.
- i. Refrigerant suction pressure in psig.
- j. Refrigerant suction temperature in deg F.
- k. Inlet steam pressure in psig.

G. Gas Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

- a. System identification.
- b. Location.
- c. Make and type.
- d. Model number and unit size.
- e. Manufacturer's serial number.
- f. Fuel type in input data.
- g. Output capacity in Btu/h.
- h. Ignition type.
- i. Burner-control types.
- j. Motor horsepower and rpm.
- k. Motor volts, phase, and hertz.
- l. Motor full-load amperage and service factor.
- m. Sheave make, size in inches, and bore.
- n. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

- a. Total airflow rate in cfm.
- b. Entering-air temperature in deg F.
- c. Leaving-air temperature in deg F.
- d. Air temperature differential in deg F.
- e. Entering-air static pressure in inches wg.
- f. Leaving-air static pressure in inches wg.
- g. Air static-pressure differential in inches wg.
- h. Low-fire fuel input in Btu/h.
- i. High-fire fuel input in Btu/h.
- j. Manifold pressure in psig.
- k. High-temperature-limit setting in deg F.
- l. Operating set point in Btu/h.
- m. Motor voltage at each connection.
- n. Motor amperage for each phase.
- o. Heating value of fuel in Btu/h.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

- a. System identification.
- b. Location.
- c. Make and type.
- d. Model number and size.
- e. Manufacturer's serial number.
- f. Arrangement and class.
- g. Sheave make, size in inches, and bore.



- h. Center-to-center dimensions of sheave and amount of adjustments in inches.
- 2. Motor Data:
  - a. Motor make, and frame type and size.
  - b. Horsepower and rpm.
  - c. Volts, phase, and hertz.
  - d. Full-load amperage and service factor.
  - e. Sheave make, size in inches, and bore.
  - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
  - g. Number, make, and size of belts.
- 3. Test Data (Indicated and Actual Values):
  - a. Total airflow rate in cfm.
  - b. Total system static pressure in inches wg.
  - c. Fan rpm.
  - d. Discharge static pressure in inches wg.
  - e. Suction static pressure in inches wg.
- I. Round and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
  - 1. Report Data:
    - a. System and air-handling-unit number.
    - b. Location and zone.
    - c. Traverse air temperature in deg F.
    - d. Duct static pressure in inches wg.
    - e. Duct size in inches.
    - f. Duct area in sq. ft.
    - g. Indicated airflow rate in cfm.
    - h. Indicated velocity in fpm.
    - i. Actual airflow rate in cfm.
    - j. Actual average velocity in fpm.
    - k. Barometric pressure in psig.
- J. Air-Terminal-Device Reports:
  - 1. Unit Data:
    - a. System and air-handling unit identification.
    - b. Location and zone.
    - c. Apparatus used for test.
    - d. Area served.
    - e. Make.
    - f. Number from system diagram.
    - g. Type and model number.
    - h. Size.
    - i. Effective area in sq. ft.
  - 2. Test Data (Indicated and Actual Values):
    - a. Airflow rate in cfm.
    - b. Air velocity in fpm.

- c. Preliminary airflow rate as needed in cfm.
- d. Preliminary velocity as needed in fpm.
- e. Final airflow rate in cfm.
- f. Final velocity in fpm.
- g. Space temperature in deg F.

K. System-Coil Reports: For reheat coils of terminal units, include the following:

- 1. Unit Data:
  - a. System and air-handling-unit identification.
  - b. Location and zone.
  - c. Room or riser served.
  - d. Coil make and size.
- 2. Test Data (Indicated and Actual Values):
  - a. Airflow rate in cfm.
  - b. Entering-air temperature in deg F.
  - c. Leaving-air temperature in deg F.

L. Instrument Calibration Reports:

- 1. Report Data:
  - a. Instrument type and make.
  - b. Serial number.
  - c. Application.
  - d. Dates of use.
  - e. Dates of calibration.

### 3.15 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of commissioning authority.
- B. Commissioning authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
- C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- E. If TAB work fails, proceed as follows:
  - 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
3. If the second verification also fails, design professional may contact AABC Headquarters regarding the AABC National Performance Guaranty.

F. Prepare test and inspection reports.

### 3.16 ADDITIONAL TESTS

- A. Within 30 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

## SECTION 230713

### DUCT INSULATION

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section includes insulating the following duct services:
  - 1. Indoor, concealed supply and outdoor air.
  - 2. Indoor, exposed outdoor air.
  - 3. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
  - 4. Indoor, concealed oven and ware wash exhaust.
  - 5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
  - 6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
  - 7. Outdoor, exposed supply and return.
- B. Related Sections:
  - 1. Section 230716 "HVAC Equipment Insulation."
  - 2. Section 230719 "HVAC Piping Insulation."
  - 3. Section 233113 "Metal Ducts" for duct liners.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
  - 2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
  - 3. Detail application of field-applied jackets.
  - 4. Detail application at linkages of control devices.
- C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
  - 1. Sheet Form Insulation Materials: 12 inches square.
  - 2. Sheet Jacket Materials: 12 inches square.

3. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.
  1. Ductwork Mockups:
    - a. One 10-foot section each of rectangular and round straight duct.
    - b. One each of a 90-degree mitered round and rectangular elbow, and one each of a 90-degree radius round and rectangular elbow.
    - c. One rectangular branch takeoff and one round branch takeoff from a rectangular duct. One round tee fitting.
    - d. One rectangular and round transition fitting.
    - e. Four support hangers for round and rectangular ductwork.
    - f. Each type of damper and specialty.
  2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
  3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
  4. Obtain Architect's approval of mockups before starting insulation application.
  5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

#### 1.8 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

#### 1.9 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

### PART 2 - PRODUCTS

#### 2.1 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge or expanded rubber materials. Comply with ASTM C 534, Type II for sheet materials.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Aeroflex USA, Inc.
    - b. Armacell LLC.

- c. K-Flex USA.
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CertainTeed Corporation.
    - b. Johns Manville; a Berkshire Hathaway company.
    - c. Knauf Insulation.
    - d. Manson Insulation Inc.
    - e. Owens Corning.
- H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CertainTeed Corporation.
    - b. Johns Manville; a Berkshire Hathaway company.
    - c. Knauf Insulation.
    - d. Manson Insulation Inc.
    - e. Owens Corning.
- I. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory applied ASJ jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CertainTeed Corporation.
    - b. Johns Manville; a Berkshire Hathaway company.
    - c. Knauf Insulation.
    - d. Manson Insulation Inc.
    - e. Owens Corning.
- J. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Armacell LLC.
- b. Nomaco Insulation.

## 2.2 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C 656, Type II, Grade 6. Tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Johns Manville; a Berkshire Hathaway company.
- B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. 3M.
    - b. CertainTeed Corporation.
    - c. Johns Manville; a Berkshire Hathaway company.
    - d. Nelson Firestop; a brand of Emerson Industrial Automation.
    - e. Thermal Ceramics.
    - f. Unifrax Corporation.

## 2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Aeroflex USA, Inc.
    - b. Armacell LLC.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. K-Flex USA.
  - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:



- a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. Mon-Eco Industries, Inc.
  - 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. Mon-Eco Industries, Inc.
  - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Dow Corning Corporation.
    - b. Johns Manville; a Berkshire Hathaway company.
    - c. P.I.C. Plastics, Inc.
    - d. Speedline Corporation.
  - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

#### 2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
  - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products.
  - b. Foster Brand; H. B. Fuller Construction Products.
  - c. Knauf Insulation.
  - d. Vimasco Corporation.
2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products.
  - b. Eagle Bridges - Marathon Industries.
  - c. Foster Brand; H. B. Fuller Construction Products.
2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products.
  - b. Eagle Bridges - Marathon Industries.
  - c. Foster Brand; H. B. Fuller Construction Products.
  - d. Knauf Insulation.
  - e. Mon-Eco Industries, Inc.
  - f. Vimasco Corporation.
2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

## 2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
  1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Childers Brand; H. B. Fuller Construction Products.
  - b. Foster Brand; H. B. Fuller Construction Products.
  - c. Vimasco Corporation.
- 3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
  - 4. Service Temperature Range: 0 to plus 180 deg F.
  - 5. Color: White.

## 2.6 SEALANTS

### A. FSK and Metal Jacket Flashing Sealants:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products.
  - b. Eagle Bridges - Marathon Industries.
  - c. Foster Brand; H. B. Fuller Construction Products.
  - d. Mon-Eco Industries, Inc.
- 2. Materials shall be compatible with insulation materials, jackets, and substrates.
- 3. Fire- and water-resistant, flexible, elastomeric sealant.
- 4. Service Temperature Range: Minus 40 to plus 250 deg F.
- 5. Color: Aluminum.
- 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- 7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

### B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Childers Brand; H. B. Fuller Construction Products.
- 2. Materials shall be compatible with insulation materials, jackets, and substrates.
- 3. Fire- and water-resistant, flexible, elastomeric sealant.
- 4. Service Temperature Range: Minus 40 to plus 250 deg F.
- 5. Color: White.
- 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- 7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.7 FACTORY-APPLIED JACKETS

### A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

- 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

## 2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering ducts.
  1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
- B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for ducts.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Foster Brand; H. B. Fuller Construction Products.
    - b. Vimasco Corporation.

## 2.9 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd.
  1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Alpha Associates, Inc.

## 2.10 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Johns Manville; a Berkshire Hathaway company.
    - b. P.I.C. Plastics, Inc.
    - c. Proto Corporation.
    - d. Speedline Corporation.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.

D. Metal Jacket:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ITW Insulation Systems; Illinois Tool Works, Inc.
  - b. RPR Products, Inc.
2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
  - a. Sheet and roll stock ready for shop or field sizing.
  - b. Finish and thickness are indicated in field-applied jacket schedules.
  - c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
  - d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.

E. Self-Adhesive Outdoor Jacket: 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross laminated polyethylene film covered with **white** aluminum-foil facing.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Polyguard Products, Inc.

2.11 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Avery Dennison Corporation, Specialty Tapes Division.
  - b. Compac Corporation.
  - c. Ideal Tape Co., Inc., an American Biltrite Company.
  - d. Knauf Insulation.
  - e. Venture Tape.
2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Avery Dennison Corporation, Specialty Tapes Division.
  - b. Compac Corporation.
  - c. Ideal Tape Co., Inc., an American Biltrite Company.
  - d. Knauf Insulation.
  - e. Venture Tape.
2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Compac Corporation.
  - b. Ideal Tape Co., Inc., an American Biltrite Company.
  - c. Venture Tape.
2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Avery Dennison Corporation, Specialty Tapes Division.
  - b. Compac Corporation.
  - c. Ideal Tape Co., Inc., an American Biltrite Company.
  - d. Knauf Insulation.
  - e. Venture Tape.
2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

## 2.12 SECUREMENTS

A. Bands:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. ITW Insulation Systems; Illinois Tool Works, Inc.
  - b. RPR Products, Inc.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch-thick, 1/2 inch wide with wing seal.
  3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch-thick, 1/2 inch wide with wing seal.
  4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated.
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) AGM Industries, Inc.
    - 2) Gemco.
    - 3) Hardcast, Inc.
    - 4) Midwest Fasteners, Inc.
    - 5) Nelson Stud Welding.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) AGM Industries, Inc.
    - 2) CL WARD & Family Inc.
    - 3) Gemco.
    - 4) Hardcast, Inc.
    - 5) Midwest Fasteners, Inc.
    - 6) Nelson Stud Welding.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) AGM Industries, Inc.
    - 2) Gemco.
    - 3) Midwest Fasteners, Inc.
  - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch-thick by 2 inches square.
  - c. Spindle: Copper or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

- d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Gemco.
    - 2) Midwest Fasteners, Inc.
  - b. Baseplate: Perforated, nylon sheet, 0.030 inch-thick by 1-1/2 inches in diameter.
  - c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
  - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) AGM Industries, Inc.
    - 2) Gemco.
    - 3) Hardcast, Inc.
    - 4) Midwest Fasteners, Inc.
  - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch-thick by 2 inches square.
  - c. Spindle: Copper or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
  - d. Adhesive-backed base with a peel-off protective cover.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) AGM Industries, Inc.
    - 2) Gemco.
    - 3) Hardcast, Inc.
    - 4) Midwest Fasteners, Inc.
    - 5) Nelson Stud Welding.
  - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.



7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Gemco.
    - 2) Midwest Fasteners, Inc.
  - C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
  - D. Wire: 0.062-inch soft-annealed, galvanized steel.
    1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      - a. C & F Wire.

## 2.13 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  1. Verify that systems to be insulated have been tested and are free of defects.
  2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

### 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces, free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
    - a. For below ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

### 3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
  - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
  - 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
  - 1. Comply with requirements Comply with requirements in architectural section of the specifications.
  - 2. firestopping and fire-resistive joint sealers.
- E. Insulation Installation at Floor Penetrations:
  - 1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
  - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in architectural section of the specifications.

### 3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.6 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
  2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
  3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - d. Do not over compress insulation during installation.
    - e. Impale insulation over pins and attach speed washers.
    - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
  4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
  5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
  6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
  7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
  2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
  3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

- a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
  - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
  - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
  - d. Do not over compress insulation during installation.
  - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
  5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
  6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

### 3.7 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
  1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
  2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
  3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
  1. Draw jacket material smooth and tight.
  2. Install lap or joint strips with same material as jacket.
  3. Secure jacket to insulation with manufacturer's recommended adhesive.
  4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
  5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
  - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

### 3.8 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in architectural sections of the specification.

### 3.9 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in architectural sections of the specifications.
  - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

### 3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
  - 1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location for each duct system defined in the "Duct Insulation Schedule, General" Article.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

### 3.11 DUCT INSULATION SCHEDULE, GENERAL

#### A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed outdoor air.
3. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
4. Indoor, concealed oven and ware wash exhaust.
5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
7. Outdoor, exposed supply and return.

#### B. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Factory-insulated access panels and doors.

### 3.12 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

#### A. Concealed, round, supply-air duct insulation shall be of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

#### B. Concealed, round, outdoor-air duct insulation, except for DOAS unit outside air, shall be of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

#### C. Concealed, rectangular, supply-air and kitchen make-up duct insulation shall be of the following:

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

#### D. Concealed, rectangular, return-air duct insulation shall be of the following:

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

#### E. Concealed, rectangular, outdoor-air duct insulation shall be of the following:

1. Mineral-Fiber Blanket: 2 inches thick and 3-lb/cu. ft. nominal density.

#### F. Concealed, rectangular, exhaust-air duct insulation, except DOAS unit exhaust air, between isolation damper and penetration of building exterior shall be of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.

#### G. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket or board; thickness as required to achieve 2-hour fire rating.

#### H. Concealed, supply-air plenum insulation shall be of the following:

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

- I. Concealed, outdoor-air plenum insulation shall be of the following:
  - 1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
- J. Concealed, exhaust-air plenum insulation shall be one of the following:
  - 1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
- K. Exposed, rectangular, outdoor-air duct insulation shall be of the following:
  - 1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
- L. Exposed, rectangular, exhaust-air duct insulation shall be of the following:
  - 1. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.
- M. Exposed, outdoor-air plenum insulation shall be of the following:
  - 1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
- N. Exposed, exhaust-air plenum insulation shall be of the following:
  - 1. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts and Plenums, Concealed:
  - 1. None.
- D. Ducts and Plenums, Exposed:
  - 1. None.
  - 2. PVC: 30 mils thick.

END OF SECTION



## SECTION 230719

### HVAC PIPING INSULATION

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section includes insulating the following HVAC piping systems:
  - 1. Condensate drain piping, indoors.
  - 2. Refrigerant suction and hot-gas piping, indoors and outdoors.
- B. Related Sections:
  - 1. Section 230713 "Duct Insulation."

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
  - 2. Detail attachment and covering of heat tracing inside insulation.
  - 3. Detail insulation application at pipe expansion joints for each type of insulation.
  - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
  - 5. Detail removable insulation at piping specialties.
  - 6. Detail application of field-applied jackets.
  - 7. Detail application at linkages of control devices.
- C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use.
  - 1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
  - 2. Sheet Form Insulation Materials: 12 inches square.
  - 3. Jacket Materials for Pipe: 12 inches long by NPS 2.
  - 4. Sheet Jacket Materials: 12 inches square.
  - 5. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

## 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.
  - 1. Piping Mockups:
    - a. One 10-foot section of NPS 2 straight pipe.
    - b. One each of a 90-degree threaded, welded, and flanged elbow.
    - c. One each of a threaded, welded, and flanged tee fitting.
    - d. One NPS 2 or smaller valve, and one NPS 2-1/2 or larger valve.
    - e. Four support hangers including hanger shield and insert.
    - f. One threaded strainer and one flanged strainer with removable portion of insulation.
    - g. One threaded reducer and one welded reducer.
    - h. One pressure temperature tap.
    - i. One mechanical coupling.
  - 2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
  - 3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
  - 4. Obtain Architect's approval of mockups before starting insulation application.
  - 5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

#### 1.8 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

#### 1.9 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

### PART 2 - PRODUCTS

#### 2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Aeroflex USA, Inc.

- b. Airex Manufacturing.
- c. Armacell LLC.
- d. K-Flex USA.

## 2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Aeroflex USA, Inc.
    - b. Armacell LLC.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. K-Flex USA.
  - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
  - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Foster Brand; H. B. Fuller Construction Products.
    - c. Knauf Insulation.
    - d. Vimasco Corporation.
  - 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
  - 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.

- b. Eagle Bridges - Marathon Industries.
  - c. Foster Brand; H. B. Fuller Construction Products.
2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
  3. Service Temperature Range: Minus 50 to plus 220 deg F.
  4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
  5. Color: White.

## 2.4 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Foster Brand; H. B. Fuller Construction Products.
    - c. Vimasco Corporation.
  3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
  4. Service Temperature Range: 0 to plus 180 deg F.
  5. Color: White.

## 2.5 SEALANTS

- A. Joint Sealants:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. Mon-Eco Industries, Inc.
    - e. Pittsburgh Corning Corporation.
  2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. Mon-Eco Industries, Inc.
  3. Materials shall be compatible with insulation materials, jackets, and substrates.
  4. Permanently flexible, elastomeric sealant.
  5. Service Temperature Range: Minus 100 to plus 300 deg F.
  6. Color: White or gray.
  7. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

8. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. FSK and Metal Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products.
  - b. Eagle Bridges - Marathon Industries.
  - c. Foster Brand; H. B. Fuller Construction Products.
  - d. Mon-Eco Industries, Inc.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.6 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
  1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

## 2.7 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Johns Manville; a Berkshire Hathaway company.
    - b. P.I.C. Plastics, Inc.
    - c. Proto Corporation.
    - d. Speedline Corporation.
  2. Adhesive: As recommended by jacket material manufacturer.
  3. Color: Color-code jackets based on system.
  4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

- a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Metal Jacket:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ITW Insulation Systems; Illinois Tool Works, Inc.
  - b. RPR Products, Inc.
- 2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
  - a. Sheet and roll stock ready for shop or field sizing.
  - b. Finish and thickness are indicated in field-applied jacket schedules.
  - c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
  - d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
  - e. Factory-Fabricated Fitting Covers:
    - 1) Same material, finish, and thickness as jacket.
    - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    - 3) Tee covers.
    - 4) Flange and union covers.
    - 5) End caps.
    - 6) Beveled collars.
    - 7) Valve covers.
    - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Self-Adhesive Outdoor Jacket: 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross laminated polyethylene film covered with white aluminum-foil facing.

- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Polyguard Products, Inc.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Avery Dennison Corporation, Specialty Tapes Division.
  - b. Compac Corporation.
  - c. Ideal Tape Co., Inc., an American Biltrite Company.

- d. Knauf Insulation.
  - e. Venture Tape.
2. Width: 3 inches.
  3. Thickness: 11.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

## 2.9 SECUREMENTS

### A. Bands:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ITW Insulation Systems; Illinois Tool Works, Inc.
  - b. RPR Products, Inc.
2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch-thick, 1/2 inch wide with closed seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

### B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

### C. Wire: 0.062-inch soft-annealed, galvanized steel.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. C & F Wire.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- #### A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems to be insulated have been tested and are free of defects.
  2. Verify that surfaces to be insulated are clean and dry.
  3. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- #### A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- #### B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F.



Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  1. Install insulation continuously through hangers and around anchor attachments.
  2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
  2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
  3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
    - a. For below-ambient services, apply vapor-barrier mastic over staples.
  4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
  2. Testing agency labels and stamps.
  3. Nameplates and data plates.
  4. Cleanouts.

### 3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
  4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install

- insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
  4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in architectural sections of the specifications for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
  2. Seal penetrations through fire-rated assemblies. Comply with requirements in architectural sections of the specifications.
- 3.5 GENERAL PIPE INSULATION INSTALLATION
- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, and Unions:
1. Install insulation over fittings and unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
  2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
  3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  4. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
  5. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
  6. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
  2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
  3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
  4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
  5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### 3.6 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

B. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

### 3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints, for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

### 3.9 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of brazed and soldered fittings for each pipe service defined in the "Piping Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

### 3.10 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

### 3.11 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate Drain Water below 60 Deg F:
  - 1. All Pipe Sizes: Insulation shall be the following:
    - a. Flexible Elastomeric: 3/4 inch thick.
- B. Refrigerant Suction and Hot-Gas Piping:
  - 1. All Pipe Sizes: Insulation shall be the following:
    - a. Flexible Elastomeric: 1 inch thick.
- C. Refrigerant Suction and Hot-Gas Flexible Tubing:
  - 1. All Pipe Sizes: Insulation shall be the following:
    - a. Flexible Elastomeric: 1 inch thick.
- D. Refrigerant Suction and Hot-Gas Piping:
  - 1. All Pipe Sizes: Insulation shall be the following:
    - a. Flexible Elastomeric: 2 inches thick.
- E. Refrigerant Suction and Hot-Gas Flexible Tubing:
  - 1. All Pipe Sizes: Insulation shall be the following:
    - a. Flexible Elastomeric: 2 inches thick.

### 3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Exposed:
  - 1. Painted Aluminum, Smooth: 0.016 inch thick.

### 3.13 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Exposed:
  - 1. Aluminum, Corrugated with Z-Shaped Locking Seam: 0.020 inch thick.

END OF SECTION

SECTION 230800  
COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 DESCRIPTION

- A. General provisions and other mechanical systems are specified in other Sections of Division 23.
- B. Commissioning is an ongoing process and shall be performed throughout construction. Commissioning requires the participation of Division 23 to ensure that all systems are operating in a manner consistent with the Contract Documents. Division 23 shall be familiar with the commissioning plan issued by the CA as it applies to the work of Division 23 and shall execute all commissioning responsibilities assigned to them in the Contract Documents. The contractors should also review Specifications Section 019113 for additional information.
- C. Commissioning shall conclude with the completion of all required deferred testing, training and system documentation as specified and required to ensure the proper operation of the mechanical equipment and systems provided by this Division.
- D. This Section covers mechanical systems commissioning, as required to demonstrate that the equipment and systems of Division 23 are ready for safe and satisfactory operation, as defined by project documents. Commissioning shall include, but shall not be limited to, identification of piping and equipment, cleaning, lubrication, start-up, check-out, and testing, adjusting, and balancing of systems, preparation of equipment and systems documentation and of maintenance and operation manuals, Owner training, and preparation of record drawings.
- E. This section does not alter the commissioning requirements indicated in Section 230000 of the building specifications. This section is to help define/supplement the requirements of Section 230000 where applicable.

1.4 QUALITY ASSURANCE

- A. The mechanical contractor shall identify a mechanical commissioning supervisor. The mechanical commissioning supervisor should have a minimum of ten years experience in mechanical contracting. The mechanical commissioning supervisor shall become familiar with the design intent and the requirements of the commissioning process as defined in this Section. The mechanical commissioning supervisor shall attend all commissioning meetings and coordinate the commissioning schedule as outline by the commissioning agent. The mechanical commissioning supervisor shall assist the CA in coordinating and executing the required commissioning activities.

## 1.5 MECHANICAL CONTRACTOR RESPONSIBILITIES

- A. The mechanical commissioning supervisor shall be responsible for scheduling, supervising, and coordinating the startup, testing, and commissioning activities as specified herein with the CA. Specific requirements of the mechanical contractor and associated subcontractors are identified in this Section and in other Sections of this Division.
- B. The CA shall conduct independent verification of installation, pre-functional, start-up and functional testing as per section 019113.
- C. Mechanical commissioning shall take place in three phases. Commissioning requirements for each phase are as follows:
  - 1. Construction Phase
    - a. Contractor shall attend a Commissioning Scoping meeting and additional commissioning meetings as required throughout the commissioning process. These commissioning meetings will be monthly during early construction and may increase in frequency to weekly during the start-up, prefunctional and functional testing phases. Contractor shall assure that all subcontractors who have commissioning responsibilities attend the Commissioning Scoping meeting and other commissioning meetings, as appropriate, during the construction process.
    - b. Contractor shall report in writing to the CA at least as often as commissioning meetings are scheduled concerning the status of his activities as they affect the commissioning process, the status of each discrepancy identified, the prefunctional and functional testing process, explanations of any disagreements with the identified deficiencies, and proposed resolution and schedule.
    - c. Contractor shall provide the CA with normal cut sheets and shop drawing submittals of equipment that is to be commissioned.
    - d. Contractor shall provide documentation to the CA for development of pre-functional and functional performance testing procedures, prior to normal O&M manual submittals. This documentation shall include detailed manufacturer installation, start-up, operating, troubleshooting and maintenance procedures; full details of any owner-contracted tests; fan and pump curves; full factory testing reports, if any; and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation, start-up, and checkout materials that are shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Agent. The Commissioning Agent may request further documentation necessary for the development of functional performance testing and the commissioning process. This data request may be made prior to normal submittals.
    - e. Contractor shall develop and submit to CA, for review prior to equipment or system startup, a complete startup and initial checkout plan using manufacturer's start-up procedures. The commissioning agent shall conduct their own pre-functional testing check in parallel with the contractors.
    - f. Contractor shall review the commissioning agent's pre-functional check sheets and sign-off on the appropriate areas when contractor and sub-



contractors are complete. The prefunctional test sheets will be developed by the commissioning agent. Only when each portion of the pre-functional test sheet is signed off will the contractor be able to move onto the next phase of the start-up and check-out. Detailed in Specification Section 019113, 2.1 "Overview Sign-Off Sheet"

- g. Contractor shall provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, to the CA for review.
- h. Contractor shall assist in clarifying the proposed operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
- i. CA shall prepare the specific functional test procedures as specified herein. The contractors shall review the CA's proposed functional performance test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
- j. Commissioning agent shall prepare a preliminary schedule for Division 23 commissioning activities, to include pipe and duct system testing, flushing, and cleaning, equipment start-up, and TAB start and completion, for use by the CA and shall update the schedule as appropriate. The contractor shall update the commissioning activities and notify any delays in the progress meetings. Contractor shall notify the CA during the commissioning meetings when commissioning activities not yet performed or not yet scheduled will delay construction.
- k. Mechanical equipment start-up shall not be initiated until the complete sign-off of the pre-functional check-sheets as developed by the commissioning agent as specified in other Sections of Division 23.
- l. Contractor shall provide startup testing for all HVAC equipment, including the building automation control system and shall execute the mechanical-related portions of the prefunctional checklists for all commissioned equipment during the startup and initial checkout process. The commissioning agent shall conduct an independent start-up once the contractor is complete with their requirements.
- m. Contractor shall perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CA.
- n. Contractor shall correct current A/E punch list and CA deficiency items before functional performance testing can begin. Air and water TAB shall be completed with discrepancies and problems remedied before functional testing of the respective air or water related systems.
- o. The commissioning agent shall generate the functional testing procedure and provide record to the mechanical contractor. The mechanical contractor shall review and provide support to the functional testing process. Contractor shall operate chillers, pumps, etc and systems in accordance with the CA requirements, open and close disconnects and switch normal and emergency power requirements as directed by the commissioning agent and the functional testing procedures.
- p. Contractor shall report in writing to the CA at least as often as commissioning meetings are being scheduled concerning the status of each outstanding discrepancy identified during commissioning, prefunctional and functional performance testing. Report shall include description of the identified discrepancy, explanations of any disagreements, and proposals and schedule for correction of the discrepancy.

- 2. Acceptance Phase. Contractor shall assist and cooperate with the CA in the commissioning process by:

- a. Putting all HVAC equipment and systems into operation and continuing the operation during each working day of the test and balance and commissioning effort, as required.
  - b. For a given area, have all required prefunctional checklists, calibrations, startup and selected functional tests of the mechanical system and associated controls completed and approved by the CA prior to beginning the test and balance process.
  - c. Provide a qualified technician to operate the controls as required to assist the TAB contractor in performing TAB or provide sufficient training for TAB to operate the system without assistance.
  - d. Provide a TAB representative to assist the CA on conducting a random 10% check of the air and water distribution requirements.
  - e. Including cost of sheaves and belts that may be required to obtain required equipment performance, as measured by the test and balance effort.
  - f. Providing test holes in ducts and plenums where directed by TAB to allow air measurements and air balancing. Providing an approved plug.
  - g. Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.
  - h. Installing a P/T plug at each water sensor that is an input point to the Control System.
  - i. Providing skilled technicians to execute starting and operation of equipment.
  - j. The commissioning agent will conduct functional performance testing. The contractor may be required to have a skilled technician present during functional testing although it is suggested that one be available to make adjustments or assist in problem-solving.
  - k. The commissioning will require full and part load performance verifications as well as seasonal and simulated testing requirements. The contractor shall be prepared to operate different components of various systems (example, chilled water and hot water systems to generate loading strategies) during the functional testing.
  - l. Correct deficiencies (differences between specified and observed performance) as interpreted by the CA and A/E.
  - m. Prepare O&M manuals according to the Contractor Documents, including clarifying and updating the original sequence of operation to as-built conditions.
  - n. Maintain on site redline as built drawings and produce final "As-built" drawings for all project drawings and contractor-generated coordination drawings. List and clearly identify on the as-built drawings the locations of all airflow stations and sensor installations that are not equipment mounted.
  - o. Provide specified training of the Owner's operating personnel in accordance with the commissioning agent's overview and outline.
  - p. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
  - q. Provide updated diagrammatical logic for all TAB adjustments to the system.
3. Warranty Period. During the warranty period, the contractor shall:
- a. Be available during seasonal or deferred functional performance testing conducted by the CA, according to the specifications.
  - b. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

## 1.6 TAB CONTRACTOR RESPONSIBILITIES

1. Six weeks prior to the starting of the T&B, submit to the commissioning agent, the qualifications of the site technician(s) for the project, including three (3) names of contractors and facility managers of recent projects on which the personnel were in charge. The Owner and CA will approve the site technician for this job.
2. Three months prior to the start of the TAB, the TAB Contractor shall submit a plan and approach for each system. The plan shall be reviewed by the CA for review and approval. The submitted plan shall include:
  - a. Certification that the TAB contractor has reviewed the construction documents and the systems with the design engineers and contractors to sufficiently understand the design intent for each system
  - b. An explanation of the intended use of the building control system.
  - c. All field check-out sheets and logs to be used that lists each piece of equipment to be tested adjusted and balanced with the data cells to be gathered for each.
  - d. Final test report forms to be used during this process
  - e. Detailed step by step procedures for TAB work for each system and issue: terminal flow calibration, diffuser proportioning, branch and submain proportioning, total flow calculations, rechecking diversity issues.
  - f. List all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of each of the test procedures, parameters, and formulas to be used.
  - g. Details of how total flow will be determined (Air: sum of terminal flows via BMS calibrated readings or via hood, pitot tube or flow stations. Water: pump curves, circuit setters, flow station, ultrasonic, etc,
  - h. The identification and types of measurement instruments to be used and their most recent calibration date.
  - i. Specific procedures that will ensure that both air and watersides will be operating at there lowest possible pressure at the point where the system will operate.
  - j. Confirmation that the TAB contractor understands the outside air ventilation criteria under all conditions and how this will be measured during normal, economizer and unoccupied conditions.
  - k. Details of how building static, room static and exhaust fan capacity will be checked.
  - l. Proposed selection points for traverse measurement locations on the as-built documents. Review the placement of the HVAC measurement devices for proper straight runs and accuracy.
  - m. Plan for formal progress reports including scope and frequency
  - n. Plan for formal deficiency reports including scope and frequency.
3. TAB contractor shall attend commissioning meetings as directed by the commissioning agent and the CM.
4. TAB contractor shall communicate in writing to the controls contractor and the commissioning agent all setpoint and parameter changes made, or problems and discrepancies identified during the TAB process that would affect the control loop system set-up and operation.
5. Submit written report of discrepancies, deficit or uncompleted work by others, contract interpretation requests and list of completed tests to the CA at least once per week.
6. After the TAB plan is accepted and two-weeks prior to TAB work, the commissioning agent shall conduct a pre-balancing conference. Prior to the prebalancing conference, the TAB contractor shall inspect the system readiness for testing and balancing. The TAB contractor shall prepare a list of deficiencies and uncompleted work that will affect the TAB process. This list shall be submitted to the commissioning agent and the CM.

7. If applicable, the TAB contractor shall coordinate testing of the fume hood systems with the CA and the owner's environmental health and safety organization.
8. The TAB contractor shall review the projected schedule and provide, in writing, to the CA and CM any delays in the schedule and what items will require completion prior to the TAB work.
9. The CA agent shall conduct independent verification of 10% of air and water end-devices for acceptance after the TAB contractor states in writing that they are complete with Testing & Balancing. The TAB contractor shall provide a mechanic to assist the CA in this verification and shall include this in the scope and price of the Work.
10. The TAB agent shall submit the TAB report to the commissioning agent for his review and comment. All data contained shall be re-verified in the field by the commissioning agent. A minimum of ten percent of the airflow readings shall be verified by the commissioning agent using his own equipment. All selection points shall be random. Total airflow shall be verified on all mains in the supply and the exhaust ducts.

## PART 2 - PRODUCTS

### 2.1 SYSTEMS TO BE COMMISSIONED

- A. The following are systems to be commissioned.
  1. Rooftop Units
  2. Split Systems
  3. Heatpumps
  4. Exhaust Fans
  5. VAV Terminal Units
  6. ATC Controls

### 2.2 TEST EQUIPMENT

- A. All standard testing equipment required to the mechanical portion startup, initial checkout shall be provided by the contractor responsible for the equipment or system being tested. This includes TAB and controls verification.
- B. The commissioning agent shall perform their own system verification and performance check-out. The commissioning agent shall provide their own calibrated equipment as required for this testing.
- C. All testing equipment associated with functional performance verification and point-to-point required by the commissioning agent shall be the responsibility of the commissioning agent.
- D. Special equipment, tools, and instruments (only available from vendor or specific to a piece of equipment) required for the functional testing of that equipment, according to the requirements of the contract documents and the functional test procedures shall be provided to the CA by the installing contractor and shall become the property of the Owner at project completion as indicated in the specification.
- E. Proprietary test equipment and software required by any manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall

become the property of the Owner upon successful completion of the commissioning process as required in the specifications.

### PART 3 - EXECUTION

#### 3.1 SUBMITTALS

- A. Division 23 shall provide submittal documentation relative to commissioning as required in this Section Part 1 and Section 019113.

#### 3.2 STARTUP PLAN AND PREFUNCTIONAL TESTING

- A. The contractor and associated subcontractors shall be responsible for the installation of complete systems and sub-systems, fully functional, meeting the design objectives of the Contract Documents. Contractor shall follow the approved start-up, initial checkout, and prefunctional testing procedures. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility to the commissioning agent or Owner.
- B. Prefunctional testing as directed and performed by the commissioning agent shall be required for each piece of equipment to ensure that the equipment and systems are properly installed and ready for operation so that functional performance testing may proceed without delays. Sampling strategies shall not be used for prefunctional testing. The prefunctional testing for all equipment and subsystems of a given system shall be successfully completed and documented prior to functional performance testing of the system. The mechanical contractor and sub-contractors shall sign off on the CA's pre-functional test sheets that they are complete, and the system is ready. The commissioning agent will verify and conduct their own independent verification and start-up in parallel to the contractor's verification. Any deficiencies identified during this process shall be noted and reviewed by the contractors. Start-up and functional testing shall not proceed until all the deficiencies are corrected and verified by the commissioning agent.
- C. The following procedures shall apply to all equipment and systems to be commissioned.
  - 1. Start-up and Initial Checkout Plan. The Commissioning Agent shall develop the detailed start-up and prefunctional testing plans for all scheduled equipment. The primary role of the CA in this process shall be to review the installation for construction completeness and ensure that all components have been installed as per the design documents. Only when pre-functional testing is complete and signed off by all contractors, shall the equipment be start-up by the contractor. Equipment and systems to be commissioned are identified in this Section Part 2.
  - 2. The start-up and initial checkout plan shall consist of the following as a minimum:
    - a. The manufacturer's standard written start-up and checkout procedures copied from the installation manuals and manufacturer's normally used field checkout sheets. The plan shall include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.
    - b. First-run checklist for equipment, to include:
      - 1) Equipment properly set.
      - 2) Alignment of shafts and couplings.
      - 3) Adjustment of vibration isolators.
      - 4) Piping and equipment properly connected.
      - 5) Completion of initial lubrication procedures.
      - 6) Clean filters in place, as appropriate.
      - 7) Wiring properly connected.

- 8) Electrical overload relays appropriate for load.
  - 9) Electrical accessories properly installed and adjusted.
  - 10) Controls, safeties, and time switches properly calibrated and set-up
  - 11) Verification of direction of motor rotation after final electrical connections by jogging motor.
  - 12) Measurements of ampere draw of electric motors and comparison with nameplate rating and with overload heater ratings.
- 3. The Commissioning Agent shall determine which trade is responsible for executing and documenting each of the line-item tasks and note that trade on the form. Each form may have more than one trade responsible for its execution.
  - 4. The Contractor shall submit the startup reports to the CA for review.
- D. The CA shall review and approve the procedures and the format for documenting them, noting any procedures that need to be added.
  - E. Two weeks prior to startup, the contractor shall schedule startup and checkout with the Owner and CA. The execution of the startup and checkout shall be directed and performed by the contractor, in accordance with manufacturer's published procedures and with the approved procedures. The CA shall be present for the contractor's required startup and checkout of all systems and equipment to be commissioned.
  - F. Sensor Calibration. Calibration of all sensors shall be included as part of the prefunctional testing and listed on the appropriate test checklists and reports, according to the specified procedures and accuracies for the devices and systems being tested.
  - G. All contractor responsible start-up, checkout forms shall be completed and submitted to the CA for review.

### 3.3 FUNCTIONAL PERFORMANCE TESTS

- A. Functional Performance Verification (FPV) is the dynamic testing of systems (rather than just individual components) under full, part, and seasonal requirements. Systems are tested under various loads and control sequences, such as low cooling and heating loads, component failures, unoccupied modes, fire alarm, etc. The systems are run through all the control sequences of operation and components are verified to be responding as the design intent and documents. Functional performance verification shall include testing all sequences of operations, verification of system capacity, generating simulated signals to simulate sensor values, conducting simulated conditions to tests all loads and verify system performance during all conditions of operation and verifying design intent. In addition, each system shall be tested through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part, and full load). Proper responses such as power failures, freeze conditions, low-oil pressures, equipment failures, etc. shall also be tested. The commissioning authority develops the functional test sheets and procedures in sequential written form, coordinates the testing, conducts the testing, and documents the testing. Each contractor is required to supply personnel to assist during the functional performance testing where applicable.
- B. No system, equipment or component thereof shall be tested until the contractor and the CM has certified, in writing, that the system, equipment and / or components are complete, have been tested, adjusted, and balanced and are ready for validating and performance testing. Functional Performance Verification is scheduled by the commissioning agent after the pre-functional testing requirements are complete and signed-off by the CM and the CA. Functional Performance Verification will not be conducted until a written notice of completion by the CM confirming that the system is ready for FPV. The air balancing and water balancing must be complete, and the controls must be debugged prior to the performance verification.

- C. Functional testing shall be conducted by the commissioning agent. Functional testing may not proceed until the systems have been properly installed, started-up and all deficiencies have been corrected.
- D. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CA and CM. Beginning system testing before full completion shall not relieve the Contractor from fully completing the system, including all prefunctional checklists.
- E. The contractor shall provide personnel to operate the systems while functional performance testing is commencing. This shall include but not be limited to; starting and stopping of systems, opening, and closing valves to create false loads on the system (with the capabilities of the existing system) and allowing the commissioning agent to manipulate the building automation systems to modulate the system requirements.
- F. The contractor shall review the commissioning functional performance testing procedure supplied by the commissioning agent. After functional testing commences, the contractor and the commissioning agent shall sign the functional test record and provide the owner and the CM a copy to review. All deficiencies either corrected in the field or outstanding shall be documented on the functional test forms for review by all parties be considered substantially complete.

#### 3.4 DEFERRED TESTING

- A. Deferred Testing. The contractor shall be available to assist in seasonal testing (Summer, Winter and Intermediate), tests delayed until weather or other conditions building construction is completed, required building occupancy or loading, or other conditions are suitable for the demonstration of equipment or system's performance, as specified. These deferred tests shall be conducted in the same manner as the seasonal tests as soon as possible. Deferred testing shall be executed, documented and deficiencies corrected as specified herein for functional performance testing. Any adjustments or corrections to the O&M manuals and "As built" documents required by the results of the testing shall be made before the seasonal testing process is considered complete.

#### 3.5 TESTING DOCUMENTATION, NON-CONFORMANCE, AND APPROVALS

- A. The commissioning agent shall clearly list any outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the testing form or on an attached sheet. The testing form and any outstanding deficiencies shall be provided to the CM / Owner within two days of test completion. The CA shall review the contractor's startup testing reports and shall submit either a non-compliance report or an approval form to the contractor. The CA shall work with the contractor and others as necessary, to correct and retest deficiencies or uncompleted items. The contractor shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner and shall notify the CA as soon as outstanding items have been corrected and resubmit an updated start-up report with a Statement of Correction on the original non-compliance report. When all requirements are satisfactorily completed, the CA shall recommend approval of the startup and prefunctional testing of each system and schedule the functional testing of the equipment or system.
- B. As functional performance testing progresses and a deficiency is identified, the CA shall discuss the issue with the executing contractor and the commissioning team.

1. When there is no dispute of the deficiency and the contractor accepts responsibility for correcting it, the CA shall document the deficiency and the contractor's response and intentions and the testing shall proceed, if possible. Corrections of minor deficiencies identified may be made by the contractor during the functional performance testing, at the discretion of the CA. Every effort shall be made or expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the commissioning effort.
  2. When the identified deficiency is corrected, the contractor shall sign the statement of correction at the bottom of the non-compliance form, certifying that the equipment is ready to be retested, and return the form to the CA. The CA shall schedule the retest of the equipment or system involved.
  3. If there is a dispute about an identified deficiency, the CA shall document the deficiency and the contractor's response and provide a copy to the contractor. Every attempt shall be made to resolve the dispute at the lowest management level possible. When the dispute resolution has been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and returns the form to the CA. The CA shall schedule the retest of the equipment or system involved. Final interpretive authority shall be the A/E. Final acceptance authority shall be the Owner.
- C. During the functional performance testing of multiple units of similar equipment, the CA will test all the installed equipment and components identified. If, under such a testing procedure, three or more, identical pieces of equipment (size along does not constitute difference) fail to perform to the requirements of the Contract Documents (mechanically or substantively) due to manufacturing defects not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the CA. In such case, the contractor shall provide the CA with the following:
1. Within one week of notification from the CA, the contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided to the CA within two weeks of the original notice.
  2. Within two weeks of the original notification, the contractor shall provide the CA and the A/E a signed and dated, written explanation of the problem, cause of failures, etc. and proposed solution, including full equipment submittals for corrective or replacement equipment, if appropriate. The proposed solution shall not be for less than the specification requirements of the original installation.
  3. When approved, two examples of the proposed solution shall be installed by the contractor and the CA shall schedule and conduct functional testing of the proposed solution. Upon completion of the functional testing of the proposed solution, the CA shall recommend the acceptance or disapproval of the proposed solution to the Owner.
  4. Upon acceptance of the proposed solution by the Owner, the contractor shall replace or repair all identical items, at their expenses and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week of approval of the proposed solution.
- D. Cost of Retesting
1. The cost for CA and/or Owner personnel to conduct the retesting of a functional performance testing requirements necessitated because a specific prefunctional or startup test item, reported to have been successfully completed, but found to be incomplete or faulty, shall be the responsibility of the contractor.
  2. For a deficiency identified during the functional testing, not related to any prefunctional checklist or start-up fault, the CA and Owner shall direct the retesting of the equipment once at "no charge" for their time. However, all costs for any subsequent retesting shall be the responsibility of the contractor.
  3. Items left incomplete, which later cause deficiencies or delays during functional testing may result in back charges to the responsible party.



### 3.6 EMERGENCY POWER / UNINTERRUPTIBLE POWER / LIFE SAFETY SYSTEMS

- A. Parties Responsible to Execute or Participate in Functional Test including Blackout Testing:
  - 1. Controls contractor: operate the controls.
  - 2. Electrical contractor: assist in testing sequences and debugging.
  - 3. Fire Alarm Contractor: Assist in the testing & debugging
  - 4. Mechanical contractor: assist in testing sequences and debugging of mechanical equipment.
  - 5. Owner staff at regional monitoring site: report communication response.
  - 6. Facility representatives: assist in testing sequences and debugging.
  - 7. Commissioning agent: conduct and coordinate testing.
- B. Integral Components or Related Equipment Being Tested:
  - 1. Automatic transfer switch
  - 2. Emergency Generator
  - 3. Building Automation System, HVAC and lighting, Fire Alarm and Fire Protection

### 3.7 OPERATION AND MAINTENANCE (O&M) MANUALS

- A. The following O&M manual requirements do not replace O&M manual documentation requirements elsewhere in these specifications. A detailed listing of O&M requirements is listed in Section 019113.
- B. Division 23 shall compile and prepare documentation for all equipment and systems covered in Division 23 and deliver this documentation to the CM for inclusion in the O&M manuals, according to this section and Section 019113, prior to the training of owner personnel.
- C. The CA shall receive a copy of the O&M manuals for review.
- D. Operation and maintenance documentation, in hardback 3-ring loose-leaf binders except full size drawings and diskettes, shall cover all mechanical systems. Documentation shall include the following: operations and maintenance documentation directory; emergency information; operating manual; emergency information; maintenance manual; test reports; and construction documents.
- E. The operation and maintenance documentation package shall be submitted as one comprehensive package to the Owner and CA before systems start-up and commissioning, and shall be updated, revised, and completed during, and at completion of, commissioning.

### 3.8 TRAINING OF OWNER PERSONNEL

- A. The commissioning supervisor shall be responsible for training coordination and scheduling of required training and for ensuring that all required training is completed. The CA shall oversee the content and adequacy of the training of Owner personnel.

- B. Prepare and submit a syllabus describing an overview of the program, describing how the program will be conducted, when and where meetings are to be held, names and company affiliations of lecturers, description of contents and outline for each lecture, and recommended reference material and outside reading. Obtain direction from the Owner on which operating personnel shall be instructed in each system. Proposed training schedules, materials, and lesson plans shall be submitted to the CA for review of the content and adequacy of the training of Owner personnel for commissioned equipment or systems.
- C. Contractor – the contractor shall have the following training responsibilities:
  - 1. Provide the CA with training plan one week before the planned training.
  - 2. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment.
  - 3. Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment.
  - 4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary, and the demonstration repeated.
  - 5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the startup technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.
  - 6. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.

### 3.9 WRITTEN WORK PRODUCTS

- A. Written work products of Contractors shall consist of the start-up and initial checkout plan and the filled-out start-up, initial checkout and prefunctional checklists.

END OF SECTION – 230800

## SECTION 230910

### INSTRUMENTATION AND CONTROL EQUIPMENT

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. This Section specifies minimum requirements for all instrumentation and control equipment and shall be fully coordinated and integrated with Division 23 and 26 sections. Provide instrumentation and control equipment, submit documentation including equipment catalogs, calibrate, test, place in service, and supply spare parts and associated labor for first year of operation for instrumentation and controls required for mechanical and electrical equipment and systems provided in accordance with Contract Documents.

- B. Related Requirements:

1. Section 230923 "Direct Digital Control System for HVAC" for equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
2. Section 230993 "Sequence of Operations for HVAC Controls".

##### 1.4 DEFINITIONS

- A. BAS: Building Automation System.
- B. BMS: Building Monitoring System.
- C. DDC: Direct-digital control.
- D. Ethernet: Local area network based on IEEE 802.3.1 standards.
- E. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.
- F. HART: Highway addressable remote transducer protocol is the global standard for sending and receiving digital information across analog wires between smart devices and control or monitoring systems through bi-directional communication that provides data access between intelligent field instruments and host systems. A host can be any software application from technician's hand-held device or laptop to a plant's process control, asset management, safety, or other system using any control platform.
- G. I/O: Input/output

- H. NBR: Nitrile butadiene rubber.
- I. PTFE: Polytetrafluoroethylene
- J. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.
- K. RS-232: A TIA standard for asynchronous serial data communications between terminal devices.
- L. RS-485: A TIA standard for multipoint communications using two twisted pairs.
- M. RTD: Resistance temperature detector.
- N. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product, including the following:
  - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  - 2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
  - 3. Product description with complete technical data, performance curves, and product specification sheets.
  - 4. Installation, operation, and maintenance instructions, including factors affecting performance.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and mounting details.
  - 2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.
  - 4. Include diagrams for air and process signal tubing.
  - 5. Number-coded identification system for unique identification of wiring, cable, and tubing ends.
- C. Delegated-Design Submittal:
  - 1. Schedule and design calculations for control actuators, including the following:
    - a. Flow at project design and minimum flow conditions.
    - b. Damper face velocity at project design and minimum airflow condition.
    - c. Pressure drop across each damper and flow sensor at project design and minimum flow condition.
    - d. Maximum close-off pressure.
    - e. Leakage flow at maximum system pressure differential.
    - f. Torque required at worst case condition for sizing actuator.
    - g. Actuator selection indicating torque provided.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Control damper installation location shown in relationship to room, duct, pipe, and equipment.
  - 2. Size and location of wall access panels for control dampers installed behind walls.
  - 3. Size and location of ceiling access panels for control dampers installed above inaccessible ceilings.
  - 4. Wall-mounted instruments located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.
- B. Product Certificates: For each product indicated requiring a certificate.
- C. Product Test Reports: For each product indicated, for tests performed by a qualified testing agency.

## 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For control valves to include in operation and maintenance manuals.

## 1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Retain paragraph below for product parts inventory over extended operating period.
- C. Provide parts, as indicated by manufacturer's recommended parts list, for product operation during one-year period following warranty period.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.
- C. Delegated Design: Engage a qualified professional, to size products where indicated as delegated design.
- D. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.
- E. Control Dampers:
  - 1. Dampers shall have stable operation throughout full range of operation, from design to minimum airflow over varying pressures and temperatures encountered.
  - 2. Control dampers shall be full size of duct or equipment connection unless otherwise indications.

- F. Air sensors and transmitters shall have an extended range of 20 percent above Project design flow and 20 percent below minimum Project flow to signal abnormal flow conditions and to provide flexibility for changes in operation.
- G. Environmental Conditions:
  - 1. Instruments shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
    - a. If instrument alone cannot meet requirement, install instrument in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated and cooled, filtered, and ventilated as required by instrument and application.
  - 2. Instruments and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures.

## 2.2 RECTANGULAR CONTROL DAMPERS

- A. General Requirements:
  - 1. Unless otherwise indicated, use parallel blade configuration for two-position control, equipment isolation service, and when mixing two airstreams. For other applications, use opposed blade configuration.
  - 2. Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.
  - 3. Damper actuator shall be factory installed by damper manufacturer as integral part of damper assembly. Coordinate actuator location and mounting requirements with damper manufacturer.
- B. Rectangular Dampers with Aluminum Airfoil Blades:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Ruskin Company.
  - 2. Performance:
    - a. Leakage: AMCA 511, Class 1A. Leakage shall not exceed 3 cfm/sq. ft. against 1-in. wg differential static pressure.
    - b. Pressure Drop: 0.05-in. wg at 1500 fpm across a 24-by-24-inch damper when tested according to AMCA 500-D, figure 5.3.
    - c. Velocity: Up to 6000 fpm.
    - d. Temperature: Minus 40 to plus 185 deg F.
    - e. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.
    - f. Damper shall have AMCA seal for both air leakage and air performance.
  - 3. Construction:
    - a. Frame:

- 1) Material: ASTM B 211, Alloy 6063 T5 extruded-aluminum profiles, 0.07 inch thick.
- 2) Hat-shaped channel with integral flange(s). Mating face shall be a minimum of 1 inch.
- 3) Width not less than 5 inches.

b. Blades:

- 1) Hollow, airfoil, extruded aluminum.
- 2) Parallel or opposed blade configuration as required by application.
- 3) Material: ASTM B 211, Alloy 6063 T5 aluminum, 0.07 inch thick.
- 4) Width not to exceed 6 inches.
- 5) Length as required by close-off pressure, not to exceed 48 inches.

c. Seals:

- 1) Blades: Replaceable, mechanically attached extruded silicone, vinyl, or plastic composite.
- 2) Jams: Stainless steel, compression type.

d. Axles: 0.5-inch-diameter plated steel, mechanically attached to blades.

e. Bearings:

- 1) Molded synthetic or stainless-steel sleeve mounted in frame.
- 2) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

- 1) Concealed in frame.
- 2) Constructed of aluminum and plated steel.
- 3) Hardware: Stainless steel.

g. Transition:

- 1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connection.
- 2) Factory mount damper in a sleeve with a close transition to mate to field connection.
- 3) Damper size and sleeve shall be connection size plus 2 inches.
- 4) Sleeve length shall be not less than 12 inches for dampers without jackshafts and shall be not less than 16 inches for dampers with jackshafts.
- 5) Sleeve material shall match adjacent duct.

## 2.3 ROUND CONTROL DAMPERS

### A. Round Dampers, Sleeve Type:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Ruskin Company.
2. Performance:

- a. Leakage: Leakage shall not exceed 0.15 cfm/in. of perimeter blade at 4-in. wg differential static pressure.
- b. Pressure Drop: 0.02-in. wg at 1500 fpm across a 12-inch damper when tested according to AMCA 500-D, figure 5.3.
- c. Velocity: Up to 4000 fpm.
- d. Temperature: Minus 25 to plus 200 deg F.
- e. Pressure Rating: Equal to or greater than pressure rating of ductwork, but minimum of 8-in. wg for sizes through 12 inches, and minimum of 6-in. wg for larger sizes.

3. Construction:

- a. Frame:
  - 1) Material: Galvanized steel, 0.04 in thick.
  - 2) Outward rolled stiffener beads positioned approximately 1 inch inboard of each end.
  - 3) Sleeve-type connection for mating to adjacent ductwork.
  - 4) Size Range: 4 to 24 inches.
  - 5) Length not less than 7 inches.
  - 6) Provide 2-inch sheet metal stand-off for mounting actuator.
- b. Blade: Double-thickness circular flat blades sandwiched together and constructed of galvanized steel.
- c. Blade Seal: Polyethylene foam seal sandwiched between two sides of blades and fully encompassing blade edge.
- d. Axle: 0.5-inch-diameter plated steel, mechanically attached to blade.
- e. Bearings: Stainless-steel sleeve pressed into frame.

2.4 ELECTRONIC CONTROL DAMPER ACTUATORS

- A. Actuators shall operate related dampers with sufficient reserve power to provide smooth modulating action or two-position action and proper speed of response at velocity and pressure conditions to which the damper is subjected.
- B. Actuators shall produce sufficient power and torque to close off or open against the maximum system pressures encountered. Actuators shall be sized to close off or open against the shutoff pressure as a minimum requirement.
- C. Position indicator and graduated scale on each actuator.
- D. Type: Motor operated, with or without gears, electric and electronic.
- E. Voltage: 24-V ac.
- F. Deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
- G. Function properly within a range of 85 to 120 percent of nameplate voltage.
- H. Provide one actuator for each damper assembly where possible. Multiple actuators required to drive a single damper assembly shall operate in unison.
- I. Avoid the use of excessively oversized actuators which could overdrive and cause linkage failure when the damper blade has reached either its full open or closed position.



- J. Use jackshafts and shaft couplings in lieu of blade-to-blade linkages when driving axially aligned damper sections.
- K. Provide mounting hardware and linkages for connecting actuator to damper.
- L. Select actuators to fail in desired position in the event of a power failure.
- M. Construction:
  - 1. For Actuators Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
  - 2. For Actuators from 100 to 400 W: Gears ground steel, oil immersed, shaft hardened steel running in bronze, copper alloy or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel or cast-aluminum housing.
  - 3. For Actuators Larger Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.
- N. Field Adjustment:
  - 1. Spring Return Actuators: Easily switchable from fail open to fail closed in the field without replacement.
  - 2. Gear Type Actuators: External manual adjustment mechanism to allow manual positioning when the actuator is not powered.
- O. Two-Position Actuators: Single direction, spring return or reversing type.
- P. Modulating Actuators:
  - 1. Operation: Capable of stopping at all points across full range and starting in either direction from any point in range.
  - 2. Control Input Signal:
    - a. Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position and other input drives actuator to close position. No signal of either input remains in last position.
    - b. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for V dc 4- to 20-mA signals.
    - c. Pulse Width Modulation (PWM): Actuator drives to a specified position according to pulse duration (length) of signal from a dry contact closure, triac sink, or source controller.
    - d. Programmable Multi-Function:
      - 1) Control Input, Position Feedback, and Running Time: Factory or field programmable.
      - 2) Diagnostic: Feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
      - 3) Service Data: Include, at a minimum, number of hours powered and number of hours in motion.
- Q. Position Feedback:
  - 1. Equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and close position.
  - 2. Equip modulating actuators with position feedback through current signal for remote monitoring.

3. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.

R. Fail-Safe:

1. Where indicated, provide actuator to fail to an end position.
2. Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.
3. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.

S. Integral Overload Protection:

1. Provide against overload throughout the entire operating range in both directions.
2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

T. Damper Attachment:

1. Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.

U. Temperature and Humidity:

1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 20 to plus 120 deg F.
2. Humidity: Suitable for humidity range encountered by application; minimum operating range shall be from 5 to 95 percent relative humidity, non-condensing.

V. Enclosure:

1. Suitable for ambient conditions encountered by application.
2. NEMA 250, Type 2 for indoor and protected applications.
3. NEMA 250, Type 4 or Type 4X for outdoor and unprotected applications.
4. Provide actuator enclosure with heater and control where required by application.

W. Stroke Time:

1. Operate damper from fully closed to fully open within 15 seconds.
2. Operate damper from fully open to fully closed within 15 seconds.
3. Move damper to failed position within 15 seconds.
4. Select operating speed to be compatible with equipment and system operation.
5. Actuators operating in smoke control systems shall comply with governing code and NFPA requirements.

X. Sound:

1. Spring Return: 62 dBA.
2. Non-Spring Return: 45 dBA.

## 2.5 AIR TEMPERATURE SENSORS

A. Platinum RTDs: Common Requirements:

1. 100 or 1000 ohms at zero deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
  2. Two-wire, PTFE-insulated, 22-gage stranded copper leads.
  3. Performance Characteristics:
    - a. Range: Minus 50 to 275 deg F.
    - b. Interchangeable Accuracy: At 32 deg F within 0.5 deg F.
    - c. Repeatability: Within 0.5 deg F.
    - d. Self-Heating: Negligible.
  4. Transmitter Requirements:
    - a. Transmitter required for each 100-ohm RTD.
    - b. Transmitter optional for 1000-ohm RTD, contingent on compliance with end-to-end control accuracy.
- B. Platinum RTD, Single-Point Air Temperature Duct Sensors:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Minco.
  2. 100 or 1000 ohms.
  3. Temperature Range: Minus 50 to 275 deg F.
  4. Probe: Single-point sensor with a stainless-steel sheath.
  5. Length: As required by application to achieve tip at midpoint of air tunnel, up to 18 inches.
  6. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
  7. Gasket for attachment to duct or equipment to seal penetration airtight.
  8. Conduit Connection: 1/2-inch
- C. Platinum RTD, Air Temperature Averaging Sensors:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Minco.
  2. 100 or 1000 ohms.
  3. Temperature Range: Minus 50 to 275 deg F.
  4. Multiple sensors to provide average temperature across entire length of sensor.
  5. Rigid probe of aluminum, brass, copper, or stainless-steel sheath.
  6. Flexible probe of aluminum, brass, copper, or stainless-steel sheath and formable to a 4-inch radius.
  7. Length: As required by application to cover entire cross section of air tunnel.
  8. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
  9. Gasket for attachment to duct or equipment to seal penetration airtight.
  10. Conduit Connection: 1/2-inch
- D. Platinum RTD Outdoor Air Temperature Sensors:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:

- a. Minco.
  - 2. 100 or 1000 ohms.
  - 3. Temperature Range: Minus 50 to 275 deg F.
  - 4. Probe: Single-point sensor with a stainless-steel sheath.
  - 5. Solar Shield: Stainless steel.
  - 6. Enclosure: NEMA 250, Type 4 or 4X junction box or combination conduit and outlet box with removable cover and gasket.
  - 7. Conduit Connection: 1/2-inch trade size.
- E. Platinum RTD Space Air Temperature Sensors:
- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Minco.
    - 2. 100 or 1000 ohms.
    - 3. Temperature Range: Minus 50 to 212 deg F.
    - 4. Sensor assembly shall include a temperature sensing element mounted under a bright white, non-yellowing, plastic cover.
    - 5. Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
    - 6. Concealed wiring connection.

## 2.6 COMBINATION AIR TEMPERATURE SENSOR AND SWITCH

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
- 1. Minco.
- B. Source Limitations: Obtain temperature-measuring sensors and transmitters and airflow from single manufacturer.
- C. Combination temperature sensor and switch in same instrument.
- D. Air Temperature Switch:
- 1. Factory preset set point of 38 deg F. Field-adjustable set point from 30 to 44 deg F.
  - 2. Responsive to coldest 12-inch section of sensor length.
  - 3. DPST latching relay rated at 25 A and 120-V ac, with powered controller, coil, and manual reset at panel. Wire one leg to fan start circuit and other leg to signal a remote alarm.
- E. Air Temperature Sensor:
- 1. Temperature-averaging type over sensor length. Length to be determined by installing trade to provide uniform coverage over air tunnel. Consult manufacturer for recommendations.
  - 2. Platinum RTD with a value of 1000 ohms at zero deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
  - 3. Accuracy: Within 0.9 deg F.
  - 4. Output Signal: 4 to 20 mA for connection to remote monitoring.
  - 5. Encase RTDs in a flexible nominal 0.375-inch-diameter sheath constructed of brass.
  - 6. Lead wires shall be 18-gage AWG copper.

7. Enclosure: NEMA 250, Type 4.

## 2.7 AIR TEMPERATURE SWITCHES

### A. Thermostat and Switch for Low Temperature Control in Duct Applications:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Honeywell International Inc.
  - b. Siemens Building Technologies, Inc.
2. Description:
  - a. Two-position control.
  - b. Field-adjustable set point.
  - c. Manual reset.
  - d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Performance:
  - a. Operating Temperature Range: 15 to 55 deg F.
  - b. Temperature Differential: 5 deg F, non-adjustable and additive.
  - c. Enclosure Ambient Temperature: Minus 20 to 140 deg F.
  - d. Sensing Element Maximum Temperature: 250 deg F.
  - e. Voltage: 120-V ac.
  - f. Current: 16 FLA.
  - g. Switch Type: Two SPDT snap switches operate on coldest 12-inch section along element length.
4. Construction:
  - a. Vapor-Filled Sensing Element: Nominal 20 feet long.
  - b. Dual Temperature Scale: Fahrenheit and Celsius visible on face.
  - c. Set-Point Adjustment: Screw.
  - d. Enclosure: Painted metal, NEMA 250, Type 1.
  - e. Electrical Connections: Screw terminals.
  - f. Conduit Connection: 1/2-inch trade size.

## 2.8 AIR TEMPERATURE RTD TRANSMITTERS

### A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Minco.

### B. Source Limitations: Obtain temperature-measuring sensors and transmitters and airflow from single manufacturer.

### C. House electronics in NEMA 250 enclosure.

1. Duct: Type 1.
2. Outdoor: Type 4.
3. Space: Type 1.

- D. Conduit Connection: 1/2-inch
- E. Functional Characteristics:
  - 1. Input:
    - a. 100-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, two-wire sensors.
    - b. 1000-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, two-wire sensors.
  - 2. Span (Adjustable):
    - a. Space: 40 to 90 deg F.
    - b. Supply Air Cooling and Heating: 40 to 120 deg F.
    - c. Supply Air Cooling Only: 40 to 90 deg F.
    - d. Supply Air Heating Only: 40 to 120 deg F.
    - e. Return Air: 50 to 100 deg F.
    - f. Mixed Air: Minus 40 to 140 deg F.
    - g. Outdoor: Minus 40 to 140 deg F.
  - 3. Output: 4- to 20-mA dc, linear with temperature; RFI insensitive; minimum drive load of 600 ohms at 24-V dc.
  - 4. Zero and span field adjustments, plus or minus 5 percent of span. Minimum span of 50 deg F.
  - 5. Match sensor with temperature transmitter and factory calibrate together.
- F. Performance Characteristics:
  - 1. Calibration Accuracy: Within 0.1 percent of the span.
  - 2. Stability: Within 0.2 percent of the span for at least 6 months.
  - 3. Combined Accuracy: Within 0.5 percent.

## 2.9 MOISTURE SENSORS AND TRANSMITTERS

- A. Sensors and Transmitters with Digital Display:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Vaisala.
  - 2. Performance:
    - a. Accuracy including non-linearity, hysteresis, and repeatability: Within 2 percent from zero to 90 percent relative humidity and within 2.5 percent from 90 to 100 percent relative humidity when operating between 60 to 77 deg F.
    - b. Relative Humidity Range: Zero to 100 percent.
    - c. Factory calibrated and NIST traceable with certificate included.
  - 3. Construction:
    - a. Provide housing with integral sensor for room applications.
    - b. Provide housing with remote sensor probe for ducted applications.

- 1) Duct Sensor Body: 300 series stainless steel or chrome-plated aluminum, at least 2 inches long for duct-mounted applications.
  - 2) Provide sensor with cable for field installation in conduit.
  - 3) For duct-mounted applications, thread the sensor assembly for connection to a threaded mounting flange.
- c. Provide general-purpose humidity sensor unless application requires special requirements. Provide sensor with sintered stainless-steel filter for duct applications.
  - d. Housing shall be ABS/PC plastic or powder-coated aluminum.
  - e. Housing Classification: NEMA 250, Type 4 or 4X.
  - f. Provide housing with wall-mounting plate.
4. Output Signal: 2-wire, 4- to 20-mA output signal with a drive capacity of at least 500 ohms at 24-V dc.
  5. Provide unit with a digital display of relative humidity in percent.
- B. Sensor and Transmitter without Display:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Vaisala.
  2. Performance:
    - a. Accuracy including non-linearity, hysteresis, and repeatability: Within 2 percent from zero to 90 percent relative humidity and within 3 percent from 90 to 95 percent relative humidity when operating at 68 deg F.
    - b. Relative Humidity Range:
      - 1) Duct: Zero to 100 percent.
      - 2) Space: Zero to 95 percent relative.
    - c. Factory calibrated and NIST traceable with certificate included.
  3. Construction for Space Applications:
    - a. Housing with integral sensor.
    - b. Housing shall be ABS plastic or powder-coated aluminum.
    - c. Enclosure: NEMA 250, Type 4.
    - d. Provide housing with a wall-mounting plate.
  4. Construction for Duct and Equipment Applications:
    - a. Housing with integral sensor.
    - b. Duct Sensor Body: 300 series stainless steel.
    - c. Provide sensor with sintered stainless-steel filter for duct applications.
    - d. Housing shall be cast aluminum.
    - e. Enclosure: NEMA 250, Type 4.
  5. Output Signal: Two-wire, 4- to 20-mA output signal with drive capacity of at least 500 ohms at 24-V dc.

2.10 COMBINATION HUMIDITY AND TEMPERATURE SENSOR AND TRANSMITTER WITH DISPLAY:

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Vaisala.

B. Description:

1. Factory package consisting of humidity and temperature sensor, digital display, keypad user interface, installation hardware, interconnecting sensor cabling, installation instructions, and operating manual.
2. Each transmitter shall be individually calibrated and provided with NIST traceable calibration certifications.
3. Provide a service cable for connecting to a notebook computer and Microsoft Windows compatible software.

C. Display:

1. Alphanumeric display of the following on the face of the enclosure:
  - a. Percent relative humidity.
  - b. Absolute humidity.
  - c. Mixing ratio.
  - d. Dry-bulb temperature.
  - e. Wet-bulb temperature.
  - f. Dew point temperature.
  - g. Enthalpy.
2. Visual display of measurement trends, and minimum and maximum values over a one-year period.

D. Electronics Enclosure:

1. Integral to sensors for wall- (room-)mounted applications and remote from temperature and humidity sensors for duct and equipment applications.
2. NEMA 250, Type 4 or 4X.
3. Labeled terminal strip for field wiring connections.

E. Output Signals:

1. Three Analog Outputs: 4 to 20 mA.

F. Temperature Sensor:

1. Temperature range matched to application, but not less than minus 40 to 140 deg F.
2. Within 0.5 deg F accuracy over the temperature range of 50 to 100 deg F and within 1 deg F over the remainder of the range.
3. Provide duct installation kit for duct applications.

G. Humidity Sensor:

1. Relative Humidity Measurement Range: Zero to 100 percent.
2. Response time in still air within 40 seconds.
3. Accuracy including non-linearity, hysteresis, and repeatability:



- a. For Temperature between Minus 4 and 104 Deg F: Within 1 percent plus 0.008 times relative humidity reading.
  4. Sintered, stainless-steel filter, protecting sensor.
  5. Provide duct installation kit for duct applications.
- H. Power Supply:
1. Field Power: 24-V ac, unless otherwise required by the application.
  2. Internal Power: As required by transmitter.

## 2.11 AIR-PRESSURE SENSORS

### A. Duct Traverse Static Pressure Sensor:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Air Monitor Corporation.
2. Sensor shall traverse the duct cross section and have at least one pickup point every 6 inches along length of sensor.
3. Construct sensor of 18-gage Type T6063-T5 extruded and anodized aluminum.
4. Sensor supported with threaded rod, sealing washer, and nut at one end and a mounting plate with gasket at other end.
5. Mounting plate with threaded, NPS 3/8 compression fitting for connection to tubing.
6. Accuracy within 1 percent of actual operating static pressure.
7. Dual offset static sensor design shall provide accurate sensing of duct static pressure in the presence of turbulent and rotational airflows with a maximum 30-degree yaw and pitch.
8. Suitable for velocities of 100 to 10000 fpm and temperatures of up to 200 deg F.
9. Sensor air resistance shall be less than 0.1 times the velocity pressure at probe-operating velocity.
10. Suitable for flat oval, rectangular, and round duct configurations.

### B. Space Static Pressure Sensor for Wall Mounting:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Air Monitor Corporation.
2. Aluminum wall plate with perforated center arranged to sense space static pressure. Exposed surfaces are provided with brush finish.
3. Wall plate provided with screws and sized to fit standard single-gang electrical box.
4. Back of sensor plate fitted with multiple sensing ports, pressure impulse suppression chamber, airflow shielding, and 0.125-inch fitting for tubing connection.
5. Performance: Within 1 percent of actual room static pressure in vicinity of sensor while being subjected to an air velocity of 1000 fpm from a 360-degree radial source.

### C. Space Static Pressure Sensor for Recessed Ceiling Mounting:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

- a. Air Monitor Corporation.
2. Aluminum round plate with perforated center arranged to sense space static pressure. Exposed surfaces provided with brush finish.
3. Sensor intended for flush mount on face of ceiling with pressure chamber recessed in ceiling plenum.
4. Back of sensor plate fitted with multiple sensing ports, pressure impulse suppression chamber, airflow shielding, and 0.125-inch fitting for concealed tubing connection.
5. Performance: Within 1 percent of actual room static pressure in vicinity of sensor while being subjected to an air velocity of 1000 fpm from a 360-degree radial source.

D. Space Static Pressure Sensor for Exposed or Suspended Mounting:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Air Monitor Corporation.
  2. Performance: Within 1 percent of actual room static pressure in vicinity of sensor while being subjected to an air velocity of 1000 fpm from a 360-degree radial source.
  3. Aluminum with perforations arranged to sense space static pressure. Exposed surfaces provided with brush finish.
  4. Sensor fitted with multiple sensing ports, pressure impulse suppression chamber, and airflow shielding.
  5. Surface-mounted sensor provided with solid mounting plate intended for mount to ceiling with pressure chamber exposed to view.
  6. Surface-mounted sensor with 0.125-inch fitting for exposed tubing connection.
  7. Suspended sensor intended for pendent mount with pressure chamber exposed to view.
  8. Suspended sensor with NPS 1/2 fitting for exposed pipe or tubing connection.

2.12 AIR-PRESSURE SWITCHES

A. Air-Pressure Differential Switch:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Dwyer Instruments, Inc.
2. Diaphragm operated to actuate an SPDT snap switch.
  - a. Fan safety shutdown applications: Switch with manual reset.
3. Electrical Connections: Three-screw configuration, including one screw for common operation and two screws for field-selectable normally open or closed operation.
4. Enclosure Conduit Connection: Knock out or threaded connection.
5. User Interface: Screw-type set-point adjustment located inside removable enclosure cover.
6. High and Low Process Connections: Threaded, NPS 1/8.
7. Enclosure:
  - a. Dry Indoor Installations: NEMA 250, Type 1.
  - b. Outdoor and Wet Indoor Installations: NEMA 250, Type 4.
  - c. Hazardous Environments: Explosion proof.

8. Operating Data:
  - a. Electrical Rating: 15 A at 120- to 480-V ac.
  - b. Pressure Limits:
    - 1) Continuous: 45 inches wg.
    - 2) Surge: 10 psig.
  - c. Temperature Limits: Minus 30 to 180 deg F.
  - d. Operating Range: Approximately 2 times set-point.
  - e. Repeatability: Within 3 percent.
  - f. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.13 AIR-PRESSURE TRANSMITTERS

### A. Air-Pressure Differential Transmitter:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Ashcroft Inc.
2. Performance:
  - a. Range: Approximately 2 times set point.
  - b. Accuracy: Within 1 percent of the full-scale range.
  - c. Hysteresis: Within 0.10 percent of full scale.
  - d. Repeatability: Within 0.05 percent of full scale.
  - e. Stability: Within 1 percent of span per year.
  - f. Overpressure: 10 psig.
  - g. Temperature Limits: Zero to 150 deg F.
  - h. Compensate Temperature Limits: 40 to 150 deg F.
  - i. Thermal Effects: 0.033 percent of full scale per degree F.
  - j. Shock and vibration shall not harm the transmitter.
3. Output Signals:
  - a. Analog Current Signal:
    - 1) Two-wire, 4- to 20-mA dc current source.
    - 2) Signal capable of operating into 800-ohm load.
4. Display: Four-digit digital display with minimum 0.4-inch-high numeric characters.
5. Operator Interface: Zero and span adjustments located behind cover.
6. Construction:
  - a. Plastic casing with removable plastic cover.
  - b. Threaded, NPS 1/4 swivel fittings for connection to copper tubing or NPS 3/16 barbed fittings for connection to polyethylene tubing. Fittings on bottom of instrument case.
  - c. Screw terminal block for wire connections.
  - d. Vertical plane mounting.
  - e. NEMA 250, Type 4.
  - f. Provide mounting bracket suitable for installation.

## 2.14 POSITION LIMIT SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - 1. OMRON Corporation.
- B. Description: Select type of actuating head (plunger, roller lever, or rod) to suit application.
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Performance:
  - 1. Life expectancy: Not less than 30 million mechanical operations and 750,000 electrical operations.
  - 2. Operating Frequency: 300 mechanical operations per minute and 30 electrical operations per minute.
  - 3. Voltage: 120-, and 480- V ac or 24- V dc, as required by application.
  - 4. Current Rating: As required by application.
  - 5. Temperature Rise: 50 deg C.
  - 6. Ambient Temperature: 14 to 175 deg F.
  - 7. Ambient Relative Humidity: 35 to 95 percent.
- D. Construction:
  - 1. NEMA 250, Type 4X enclosure.
  - 2. Switch Type: SPDT or DPDT, as required by application.
  - 3. Status indicator integral to switch. Field switchable to light when contacts are actuated and operating, or contacts are free and not operating.
  - 4. Electrical Connection: Screw or plug-in terminals.
  - 5. Conduit Connection: NPS 1/2.

## 2.15 LEAK DETECTION SWITCHES

- A. Point-Type, Leak-Detection Switches:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Veris Industries.
    - b. W. E. Anderson; Dwyer Instruments, Inc.
- B. Requirements in remaining subparagraphs are based on W. E. Anderson's "Series WD2."
  - 1. Features: Audible and visual alarm with relay output for remote indication.
  - 2. Alarm activated based on change in resistance.
  - 3. Performance:
    - a. Service: Water.
    - b. Temperature Limits: 32 to 122 deg F.
    - c. Switch Type: SPDT relay.
    - d. Electric Connection: Cable attached.
  - 4. Construction: Acrylic, ABS plastic.
  - 5. Field Power: 24-V ac or dc.

C. Cable-Type, Leak-Detection Switches:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. W. E. Anderson; Dwyer Instruments, Inc.

D. Requirements in remaining subparagraphs are based on W. E. Anderson's "Series WD."

1. Control Module Features:
  - a. Power and alarm LEDs.
  - b. Alarm test switch.
  - c. Continuous tape integrity self check.
2. Performance:
  - a. Service: Water, or other conductive liquid.
  - b. Switch Type: DPDT.
  - c. Electric Connection: Screw terminals.
  - d. Conduit Connection: 0.5 inch.
3. Construction:
  - a. Control Module Enclosure: Extruded aluminum.
  - b. Tape: Hydrophobic with connector on each end.
  - c. Tape Length: As required for application. Field extendable.
4. Field Power: 24-V ac or V dc.

2.16 CARBON DIOXIDE (CO<sub>2</sub>) SENSORS

- A. CO<sub>2</sub> sensor shall be either wall or duct mounted as shown in the design and shall utilize a non-dispersive infrared (NDIR) sensing method to provide a direct readout of CO<sub>2</sub> levels over range of 0 to 2000 ppm. Sensor shall provide a linear output signal that can be linked to BCS.
- B. CO<sub>2</sub> sensor shall have the following characteristics:
  1. Gas Detected: Carbon Dioxide (CO<sub>2</sub>).
  2. Sensing Method: Single-beam, non-dispersive infrared (NDIR).
  3. Measurement Range: 0 to 2000 ppm.
  4. Accuracy: Plus, or minus 5 percent of reading and plus or minus 50 ppm at 77 degrees F.
  5. Max Annual Drift: 20 ppm (nominal).
  6. Repeatability: Plus, or minus 20 ppm.
  7. Output Drift: Maximum 2 percent of full range.
  8. Operating Range:
    - a. Humidity: 5 to 95 percent RH, non-condensing.
    - b. Temperature: 32 to 104 degrees F.
  9. Output Signal:
    - a. Current: 4 to 20 mA dc.

10. Response Time: 1 minute to 90 percent of step change.
11. Calibration:
  - a. Adjustment: Zero and span.
  - b. Interval: By usage, one (1) year maximum recommended.
12. Mounting: Space or duct as required.

C. Approved Manufacturer:

1. Vaisala.
2. GE Sensing TelAire.
3. Honeywell.
4. Johnson Controls.
5. Siemens.
6. BAPI.

2.17 LOCAL UNIT CONTROL PANELS

- A. Panels shall be NEMA 1 (if located indoors) or NEMA 4 (if located outdoors) enclosures at least 24 inches wide, 12 inches high and a minimum of 8 inches deep or 6 inches deep in finished spaces, with a locking door. Total panel, including removable backplate for equipment mounting, shall be made rust-resistant and painted with epoxy enamel. All door locks shall operate from a common key.
- B. Each item of terminal equipment (for example, dampers) controlled from panel-mounted devices shall be provided with a flush-mounted panel-door air gage at least 2 inches in diameter.
- C. Provide separate temperature gages for all duct-mounted sensors located as indicted and, as a minimum, shall include mixed-air, discharge-air and return-air ducts, and ducts downstream of preheat coils. Gages shall be a minimum of 2 1/2 inches in diameter with plus or minus 1 percent full-scale accuracy.
- D. Gages and control devices of fan system shall be placed in one (1) group for each system on a hinged control panel door so that complete operation of all equipment can be checked simultaneously at panel. Piping shall be inside panel.
- E. Manually-operated switches, gradual switches and pilot lights shall be door mounted.
- F. Provide lamacoid nameplates, with 3/16-inch engraved black letters on white background, permanently secured in place describing panel device. Clearly identify items as to function, switch position, temperature, location, and type of temperature controller. Use of plastic tape is acceptable.
- G. Other control devices shall be located inside panel and mounted to allow sufficient space for both interconnecting wiring. Interior panel wiring shall be arranged in a systematic, orderly manner and brought to terminal blocks for connection of field wiring. Low-voltage and line-voltage terminals shall be isolated from each other.
- H. Furnish Record Drawings in a plastic pocket affixed inside panel to show systems and devices controlled from panel.

## 2.18 WEATHERSHIELDS

- A. Provide appropriate weather housings for temperature and Relative Humidity sensors installed outdoors.
- B. Housings shall prevent sun from directly striking sensors and shall not radiate to sensors. Provide adequate ventilation so that sensor responds to ambient environmental conditions of surrounding.
- C. Shields shall be compatible with surface on which they are installed. Housings shall be as indicated.

## 2.19 CONTROL RELAYS

- A. Control relays shall be of electro-mechanical type with coils for 120 V ac, 60 Hz power, and shall have contacts suitable for required load without contact bounce.
- B. Relays shall have normally open (N. O.) and normally closed (N.C) contacts, as required, with quantity of poles required to perform indicated functions.
- C. Approved Manufacturers:
  - 1. Ptter-Brumfield.
  - 2. Agastat.
  - 3. Magnecraft.
  - 4. IDEC.

## 2.20 INSTRUMENTATION CABLE

- A. Cable shall be designed for transmitting a two-wire current signal over required distance.
- B. Cable shall contain two (2) conductors, 7 strands each, 100 percent shielded in an aluminum-polyester foil shield, and one (1) stranded conductor drain wire. Conductors shall be NO. 18 AWG wire covered with minimum 15 mil thick fire-retardant PVC insulation. Drain wire shall be No. 20 AWG. All wires shall be encased in a minimum 35 mil thick fire-retardant PVC jacket.
- C. Cable shall be UL listed PLTC for 300-volt operation.
- D. Approved Manufacturers:
  - 1. Belden.
  - 2. Alpha.
  - 3. Dekron.

## 2.21 PLENUM CABLE

- A. In areas served by mechanical ventilation or air handling systems where space above ceiling acts as an air plenum and local codes permit, provide plenum cable specifically formulated and manufactured for low-smoke and low-flame spread classification in place of other insulated wire in conduit, if desired.
- B. Power-limited circuit cable (CLZP) shall be UL listed for Class 2 circuits installed as wiring within plenum of a building, shall be resistant to spread of fire, shall have low smoke characteristics, and shall have been subjected to and passed UL 910.

- C. Paragraph 727-38b (3) of NFPA 70 shall apply.
- D. Cable can be installed without conduit in plenums.
- E. Acceptable conductor insulation types are:
  1. Teflon FEP (Fluorinated ethylene propylene).
  2. Halar E-CTFE (Ethylene chlorotrifluoroethylene).
  3. Kynar PVDF (Polyvinylidene fluoride).
- F. Acceptable manufacturers are:
  1. Dekoron by Fluorocarbon/Samuel Moore Group.
  2. Alpha Wire Corporation.
  3. Ausimont USA, Inc.
  4. Belden Wire and Cable.

## 2.22 WIRING AND TERMINALS

- A. Electrical wiring within equipment cabinets shall be neatly arranged in Panduit, properly supported, and terminated on one (1) side of terminal blocks only so that external connections for control, instrumentation, and auxiliary power can be made to other side of terminal blocks inside each equipment cabinet. Instrument connections shall be protected in a NEMA 1 enclosure, unless in a damp or wet location, in which a NEMA 4 enclosure shall be used in accordance with NEPA 70. No connections shall be exposed.
- B. At least 20 percent spare unused terminals shall be provided in each group of terminal blocks. Control circuits and power circuits shall be completely separated by use of divided or separate terminal blocks. Terminal blocks for external connections shall be General Electric, Weidmuller, Phoenix Contact or Woertz, designed to accommodate up to No. 12 AWG cable. No more than 2 wires shall be connected to anyone (1) terminal block screw. Wire connections shall be made with horseshoe or ring-tongue compression terminals unless terminal block is specifically designed for bare wire connection. Stranded wire shall connect to terminal block with insulated ferrules. Label terminal blocks and each device termination.

## 2.23 CURRENT TRANSFORMERS

- A. Provide a donut-type current transformer with a 0 to 5 ampere ac output.
- B. Current transformer shall be compatible with current transducers specified below.

## 2.24 CURRENT TRANSDUCERS

- A. Current transducer shall accept standard 0 to 5 amps ac input (150 V ac maximum) from a current transformer (CT). Input signal isolation shall be provided by a single-turn primary input transformer. Overload capability shall be 35 amps for 30 seconds.
- B. Unit output shall be a 4 to 20 mA dc signal (or other standard process current or voltage signal compatible with BCS) proportional to input current.
- C. Unit shall be powered from a 120 V ac, 60 Hz source. (Units requiring dc voltages shall be provided with 120 v ac/0 to 60 V dc power supply).
- D. Unit shall have an adjustable zero and span, with ripple less than 10 mV P/P maximum span and load.



- E. Approved Manufacturers:
  - 1. Moore Industries, Inc.
  - 2. DEVAR, Inc., Control Products Division.
  - 3. Rochester Instrument System (with dc power supply).
  - 4. Neilson-Kuljian.

## 2.25 CURRENT-SENSING RELAYS

- A. Current-sensing relays shall provide a normally open contact rated at a minimum of 50 volts peak and 1/2 ampere or 25 VA, non-inductive.
- B. There shall be a single hole for passage of current-carrying conductors.
- C. Devices shall be sized for operation at 50 percent rated current based on connected load.
- D. Voltage isolation shall be a minimum of 600 volts.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for instruments installed in piping and ductwork to verify actual locations of piping connections before installation.
- C. Confirm that proposed mounting locations comply with requirements indicated and approved submittals.
  - 1. Indicate dimensioned locations with mounting height for all surface-mounted products to walls and ceilings on shop drawings.
  - 2. Do not begin installation without submittal approval of mounting location.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION, GENERAL

- A. Furnish and install products required to satisfy most stringent requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Properly support dampers, actuators, instruments, piping, wiring, and conduits to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
- D. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

- E. Firestop penetrations made in fire-rated assemblies and seal penetrations made in acoustically rated assemblies.
- F. Fastening Hardware:
  - 1. Stillson wrenches, pliers, and other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
  - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
  - 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- G. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.
- H. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.
- I. Provide required control and interlock wiring, including smoke detectors, fire alarms (other than power), fan interlocks, control panels, and other devices for a complete and operable system, and as described System Sequences of Operation.
- J. Provide pilot-duty relays as required for interlocking of equipment as described in Sequences of Operation.
- K. Verify quantity and size of wiring required for systems.
- L. If a field-mounted device or piece of equipment requires 120 V ac service and is mounted at a difference location from 120 Vac power source provided under Electrical: Division 26, provide extensions to power wiring, including conduit, junction boxes, and other hardware, in accordance with Electrical: Division 26. This requirement shall also apply to devices powered by 24 V or greater.
- M. Thermostats, temperature sensors, humidistats and humidity sensors located on exterior walls shall be mounted on back-insulated blocks.
- N. Provide wiring for smoke detectors into control circuit of fans.
- O. Demonstrate to Owner's Representative that field wiring is installed in accordance with Electrical: Division 26 and is properly connected to appropriate device(s) as indicated and as described in Building Control System Sequences of Operation.
- P. Provide, at each duct thermostat and temperature sensor and where else indicated, direct-reading duct thermometers that are readable by a person standing on floor so that thermostat/sensor operation can be checked.
- Q. Install control panels so that they are stable and fully supported. Locate panels a minimum of 1 inch from wall.
- R. Air handling unit duct smoke detectors will be furnished under Electrical: Division 26 and mounted under Duct Accessories: Division 23. Conduit and wiring from each duct smoke detector to individual fan starter will be provided under Electrical: Division 26. Provide all final connections at fan starter for each air handling unit as indicated. Final connections at duct smoke detector end will be normally closed contacts and will be made under Electrical: Division 26.

- S. Power wiring to control panels, will be provided under Electrical: Division 26.
- T. Provide labor for coordination and preparation during testing and balancing of systems as performed under Testing and Balancing of Mechanical System.
- U. If control panels are placed at locations different from those indicated, extend related accessories, including housekeeping pads and power wiring, and other tubing and wiring, to new locations and make required connections required at new locations. Provide additional electrical wiring and related equipment other than that provided under Electrical: Division 26 in accordance with System manufacturer's written recommended instructions.
- V. If more control panels than those indicated are required, indicated requirements shall apply to additional panels.
- W. Control panels are indicated on HVAC plans for approximate location and space allocation only and are not indicated dimensionally or quantitatively. Total quantity of control panels required shall be determined by actual point capacities and spare point requirements as indicated. Provide related accessories, including extension of housekeeping pads, and power wiring to additional control panels.
- X. Provide required cooperation and coordination with Electrical: Division 26 such that power and ground wiring is provided in accordance with DDC System equipment manufacturer's written recommendations. DDC System supplier/installer shall make final electrical connections to DDC System equipment.
- Y. Coordinate with Electrical: Division 26 and associated Electrical Contract Documents to verify which items of DDC System Equipment require un-interruptible power supply (UPS) power. Provide individual and total DDC System equipment KVA load to Electrical: Division 26 in order to ensure proper UPS and feeder capacity. Provide air compressor motor load data to Electrical Installer for coordination of feeder capacity.
- Z. For NEMA 12 cabinets, provide electrical isolation between cooling fan and thermostat and electronics in cabinet such that cooling fan operation does not affect FEP operation. Provide means to drain cooling equipment condensate without piping along floors, walkways or exits.
- AA. At penetrations through designated vapor-retardant walls, as indicated on Architectural Drawings, provide patching and sealant with silicone sealant in accordance with Division 7. Also provide air and vapor tight sealing of shielded air probes (SAPs) with silicone sealant.
- BB. Temperature:
  - 1. RTDs: RTDs may be used in ducts or spaces. When installed in airstreams or spaces, RTDs shall be rigidly supported. RTDs used for space-temperature sensing shall include a housing suitable for wall mounting. RTDs used for outside-air sensing shall have an instrument shelter to minimize solar effects and shall be mounted to isolate building thermal effects. RTD assemblies shall be readily accessible and installed in such a manner as to allow for easy replacement. Sensors located outdoors shall be NEMA 4 rated.
- CC. Humidity:
  - 1. Relative Humidity: Provide air guards/sintered filters when there are air flows greater than 50 fpm across sensor element. Sensors located outdoors shall be NEMA 4 rated.
- DD. Test field equipment in conjunction with Building Control System (BCS).

### 3.3 ELECTRIC POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

### 3.4 GROUNDING

- A. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

### 3.5 CONTROL DAMPERS

- A. Install smooth transitions, not exceeding 15 degrees, to dampers smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.
- B. Clearance:
  - 1. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.
  - 2. Install dampers with at least 24 inches of clear space on sides of dampers requiring service access.
- C. Service Access:
  - 1. Dampers and actuators shall be accessible for visual inspection and service.
  - 2. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Section 233300 "Air Duct Accessories."
- D. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.
- E. Attach actuators to damper drive shaft.
- F. For duct-mounted and equipment-mounted dampers installed outside of equipment, install a visible and accessible indication of damper position from outside.

### 3.6 TEMPERATURE, RELATIVE HUMIDITY AND PRESSURE INSTRUMENT INSTALLATIONS

- A. Mounting Location:
  - 1. Roughing In:
    - a. Outline instrument mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.

- b. Provide independent inspection to confirm that proposed mounting locations comply with requirements indicated and approved submittals.
        - 1) Indicate dimensioned locations with mounting height for all surface-mounted products on Shop Drawings.
        - 2) Do not begin installation without submittal approval of mounting location.
      - c. Complete installation rough-in only after confirmation by independent inspection is complete and approval of location is documented for review by Owner and Architect on request.
  - 2. Install switches and transmitters associated with individual air-handling units and connected ductwork and piping in air-handling unit system control panel to provide service personnel a single and convenient location for inspection and service.
  - 3. Install switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
  - 4. Mount switches and transmitters on walls. Use manufacturer's mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
- B. Special Mounting Requirements:
- 1. Protect products installed outdoors from solar radiation, building and wind effect with stand-offs and shields constructed of Type 316 stainless.
  - 2. Instruments having performance impacted by temperature and relative humidity of mounting substrate shall be isolated with an insulating barrier located between instrument and substrate to eliminate effect. Where instruments requiring insulation are located in finished space, conceal insulating barrier in a cover matching the instrument cover.
- C. Mounting Height:
- 1. Mount temperature instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.
  - 2. Mount switches and transmitters located in mechanical equipment rooms and other similar space not subject to code or state and Federal accessibility requirements within a range of 42 to 72 inches above the adjacent floor, grade, or service catwalk or platform.
    - a. Make every effort to mount at 60 inches.
- D. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.
- E. Space Sensor Installation:
- 1. Conceal assembly in an electrical box of sufficient size to house sensor and transmitter, if provided.
  - 2. Install electrical box with a faceplate to match sensor cover if sensor cover does not completely cover electrical box.
  - 3. In finished areas, recess electrical box within wall.
  - 4. In unfinished areas, electrical box may be surface mounted if electrical light switches are surface mounted. Use a cast-aluminum electric box for surface-mounted installations.
  - 5. Align electrical box with other electrical devices such as visual alarms and light switches located in the vicinity to provide a neat and well-thought-out arrangement. Where possible, align in both horizontal and vertical axis.

F. Outdoor Air Sensor Installation:

1. Mount sensor in a discrete location facing north.
2. Protect installed sensor from solar radiation and other influences that could impact performance.
3. If required to have a transmitter, mount transmitter remote from sensor in an accessible and serviceable location indoors.

G. Single-Point Sensor Installation:

1. Install single-point-type, duct-mounted, supply- and return-air temperature sensors. Install sensors in ducts with sensitive portion of the element installed in center of duct cross section and located to sense near average temperature. Do not exceed 24 inches in sensor length.
2. Install return-air sensor in location that senses return-air temperature without influence from outdoor or mixed air.
3. Rigidly support sensor to duct and seal penetration airtight.
4. If required to have transmitter, mount transmitter remote from sensor at accessible and serviceable location.

H. Averaging Duct Temperature Sensor Installation:

1. Install averaging-type air temperature sensor for temperature sensors located within air-handling units, similar equipment, and large ducts with air tunnel cross-sectional area of 20 sq. ft. and larger.
2. Install sensor length to maintain coverage over entire cross-sectional area. Install multiple sensors where required to maintain the minimum coverage.
3. Fasten and support sensor with manufacturer-furnished clips to keep sensor taut throughout entire length.
4. If required to have transmitter, mount transmitter in an accessible and serviceable location.

I. Low-Limit Air Temperature Switch Installation:

1. Install multiple low-limit switches to maintain coverage over entire cross-sectional area of air tunnel.
2. Fasten and support sensing element with manufacturer-furnished clips to keep element taut throughout entire length.
3. Mount switches outside of airstream at a location and mounting height to provide easy access for switch set-point adjustment and manual reset.
4. Install on entering side of cooling coil unless otherwise indicated on Drawings.

J. Duct Pressure Sensors:

1. Install sensors using manufacturer's recommended upstream and downstream distances.
2. Unless indicated on Drawings, locate sensors approximately 67 percent of distance of longest hydraulic run. Location of sensors shall be submitted and approved before installation.
3. Install mounting hardware and gaskets to make sensor installation airtight.
4. Route tubing from the sensor to transmitter.
5. Use compression fittings at terminations.
6. Install sensor in accordance with manufacturer's instructions.
7. Support sensor to withstand maximum air velocity, turbulence, and vibration encountered to prevent instrument failure.

K. Air-Pressure Differential Switches:

1. Install air-pressure sensor in system for each switch connection. Install sensor in an accessible location for inspection and replacement.
2. A single sensor may be used to share a common signal to multiple pressure instruments.
3. Install access door in duct and equipment to access sensors that cannot be inspected and replaced from outside.
4. Route NPS 3/8 tubing from sensor to switch connection.
5. Do not mount switches on rotating equipment.
6. Install switches in a location free from vibration, heat, moisture, or adverse effects, which could damage the switch and hinder accurate operation.
7. Install switches in an easily accessible location serviceable from floor.
8. Install switches adjacent to system control panel if within 50 feet; otherwise, locate switch in vicinity of system connection

3.7 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install engraved phenolic nameplate with instrument identification.

3.8 CLEANING

- A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.
- B. Wash and shine glazing.
- C. Polish glossy surfaces to a clean shine.

3.9 CHECKOUT PROCEDURES

- A. Instrumentation Checkout: Perform the following for all instruments including control dampers:
  1. Check installed products before continuity tests, leak tests, and calibration.
  2. Check each instrument for proper location and accessibility.
  3. Check instruments for proper installation with respect to direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
  4. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.
- B. Control-Damper Checkout:
  1. Verify that control dampers are installed correctly for flow direction.
  2. Verify that proper blade alignment, either parallel or opposed, has been provided.
  3. Verify that damper frame attachment is properly secured and sealed.
  4. Verify that damper actuator and linkage attachment are secure.
  5. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
  6. Verify that damper blade travel is unobstructed.
- C. Temperature and Humidity Instrument Checkout:

1. Verify sensing element type and proper material.
2. Verify location and length.
3. Verify that wiring is correct and secure.

D. Flow Instrument Checkout

1. Verify that sensors are installed correctly with respect to flow direction.
2. Verify that sensor attachment is properly secured and sealed.
3. Verify that processing tubing attachment is secure.
4. Inspect instrument tag against approved submittal.
5. Verify that recommended upstream and downstream distances have been maintained.

### 3.10 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
4. Equipment and procedures used for calibration shall meet instrument manufacturer's written instructions.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistance source.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.



- F. Transmitters:
  - 1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
  - 2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.
- G. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
- H. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.
- I. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

### 3.11 MAINTENANCE AND SERVICE

- A. General Requirements: Provide services, and provide materials, and equipment required for successful operation of entire system and appurtenances for a period of one (1) year after Date of Acceptance by Owner and Design Professional. System acceptance shall be defined as full completion of testing and performance verified by Owner's Representative and sign-off of acceptance.
- B. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of systems and equipment Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper equipment operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
- C. Emergency Service: Supplier/Installer furnish services of a Technical Representative capable of servicing equipment at Project Site before end of working day when service call is made prior to noon. Supplier/Installer furnish services of a Technical Representative capable of servicing equipment at Project Site before noon of next working day when service call is made after noon or during evening or weekend.
- D. Personnel: Advise Owner's Representative in writing of names of designated service representative and of service personnel. Update this list when there are changes in personnel.
  - 1. Supervision: During maintenance and service, furnish services of a supervisor with full authority to act for Supplier/Installer. Supervisor shall effect daily liaison during normal working hours with Owner.
  - 2. Service Personnel: Provide qualified service personnel to adjust and repair system.
- E. Service Contract: Submit, ninety (90) days prior to expiration of Warranty Period, at time of initial bid proposal, a two (2) year extended Service Contract Proposal, which may be accepted by Owner up to end of first year Warranty Period.

### 3.12 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.

END OF SECTION

SECTION 230910.14

FLOW INSTRUMENTS INSERTS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

PART 2 - PRODUCTS

A. Performance Requirements:

1. Adjustable for changes in system operational parameters.
2. Manufacturer shall certify that each flow instrument indicated complies with specified performance requirements and characteristics.

- a. Product certificates are required.

B. Thermal Airflow Station:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

- a. Ebtron, Inc.

2. Source Limitations: Obtain airflow and temperature measuring sensors and transmitters from single manufacturer.

3. Description: Airflow station shall consist of one or more sensor probes mounted in a casing, and a remotely mounted microprocessor-based transmitter.

4. Performance:

- a. Capable of independently processing up to 16 independently wired sensor assemblies.

- b. Airflow rate of each sensor assembly shall be equally weighted and averaged by transmitter prior to output.

- c. Temperature of each sensor assembly shall be velocity weighted and averaged by transmitter prior to output.

- d. Listed and labeled by an NRTL as successfully tested as an assembly according to UL 873, "Temperature-Indicating and Regulating Equipment."

- e. Components shall be interconnected by exposed NRTL-listed plenum-rated cable or non-listed cable placed in conduit.

- f. Each flow station shall be factory calibrated at a minimum of [16] <Insert number> airflow rates and [three] <Insert number> temperatures to standards that are traceable to NIST.

- g. Airflow Accuracy: Within 2 percent of reading over the entire operating airflow range.

- 1) Devices whose accuracy is combined accuracy of transmitter and sensor probes must demonstrate that total accuracy meets the performance requirements throughout the measurement range.

- h. Temperature Accuracy: Within 0.2 deg F over entire operating range of minus 20 to plus 140 deg F.
  - i. Sensor Ambient Operating Temperature Range: Minus 20 to plus 160 deg F.
  - j. Transmitter Ambient Operating Temperature Range: Minus 20 to plus 120 deg F.
  - k. Sensor and Transmitter Ambient Operating Humidity Range: Zero to 99 percent, non-condensing.
  - l. Instrument shall compensate for changes in air temperature and density throughout calibrated velocity range for seasonal extremes at Project location.
  - m. Pressure Drop: 0.05-inch wg at 2000 fpm across a 24-by-24-inch area.
  - n. Instruments mounted in throat or face of fan inlet cone shall not negatively influence fan performance by reducing flow more than 0.5 percent of Project design flow or negatively impact fan-generated sound. Losses in performance shall be documented with submittal data, and adjustments to compensate for performance impact shall be made to fan in order to deliver Project design airflow indicated.
5. Sensor Assemblies:
- a. Each sensor probe shall contain two individually wired, hermetically sealed bead-in-glass thermistors.
  - b. Mount thermistors in sensor using a marine-grade, waterproof epoxy.
  - c. Thermistor leads shall be protected and not exposed to the environment.
  - d. Each sensor assembly shall independently determine airflow rate and temperature at each measurement point.
  - e. Each sensor probe shall have an integral cable for connection to remotely mounted transmitter.
  - f. Sensor Probe Material: Gold anodized, extruded 6063 aluminum tube or Type 304 stainless steel.
  - g. Probe Assembly Mounting Brackets Material: Type 304 stainless steel.
6. Casing:
- a. Factory mount sensor probes in an airflow station casing to create a single assembly for field mounting.
  - b. Material: Galvanized sheet steel at least 0.079 inch-thick with coating complying with ASTM A 653/A 653M, G90. Casings shall be stainless steel, 0.0781 inch-thick, when connected to stainless duct and aluminum, 0.063 inch thick, when connected to aluminum duct.
  - c. Joints and Seams: Continuously weld. Clean galvanized areas damaged by welding and coat with zinc-rich paint.
  - d. Casing Depth: At least 8 inches.
  - e. Include casing inlet and discharge connections with connection flanges.
7. Transmitter:
- a. Integral digital display capable of simultaneously displaying total airflow and average temperature, individual airflow, and temperature readings of each independent sensor assembly.
  - b. Capable of field configuration and diagnostics using an onboard push-button interface and digital display.
    - 1) Include an integral power switch to operate on 24-V ac (isolation not required) and include the following:
      - a) Integral protection from transients and power surges.

- b) Circuitry to ensure reset after power disruption, transients, and brownouts.
  - c) Integral transformer to convert field power source to operating voltage required by instrument.
- c. Remote Signal Interface:
- 1) Linear Analog Signals for Airflow and Temperature: Fuse protected and isolated, 4 to 20 mA.
  - 2) BACnet Ethernet, BACnet-IP

## 2.19 AIRFLOW SWITCHES

### A. Polymer Film Sail Switch:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Honeywell International Inc.
2. Performance:
  - a. Suitable for applications operating at velocities up to 400 fpm.
  - b. Suitable for mounting with air direction in horizontal, vertical up or down.
  - c. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - d. Voltage: 24 V ac.
  - e. Normally open switch actuates at 250 fpm and opens at 75 fpm.
  - f. Normally closed switch actuates at 75 fpm and closes at 250 fpm.
  - g. Maximum Process Temperature: 170 deg F.
  - h. Maximum Ambient Temperature: 125 deg F.
3. Construction:
  - a. Polyester film sail encasing a wire frame.
  - b. Sail actuates a SPDT snap switch.
  - c. Enclosure Material: Zinc-plated steel.
  - d. Enclosure with removable cover.
  - e. NEMA 250, Type 1 enclosure.
  - f. Removable spring counterbalances sail to allow mounting in either vertical (up or down) or horizontal airflow.
  - g. Electrical Connections: Screw terminals.
  - h. Conduit Connections: 1/2-inch trade size conduit knock outs on top and bottom.

### B. Stainless-Steel Single Vane Switch:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Dwyer Instruments, Inc.
2. Description:
  - a. Velocities up to 2000 fpm.

3. Performance:
  - a. Voltage: 24 V ac.
  - b. Field-Adjustable Velocity Set Point: 400 to 1600 fpm.
  - c. Maximum Process Temperature: 180 deg F.
  - d. Maximum Ambient Temperature: 125 deg F.
  
4. Construction:
  - a. Stainless-steel vane.
  - b. Vane actuates a SPDT snap switch.
  - c. Enclosure Material: Die-cast metal.
  - d. Enclosure with removable cover.
  - e. NEMA 250, Type 1 enclosure.
  - f. Screw set-point adjustment.
  - g. Electrical Connections: Screw terminals.
  - h. Conduit Connections: 1-inch trade size conduit knock outs on top and bottom.

## 2.20 AIRFLOW TRANSMITTERS

### A. Airflow Transmitters with 0.25 Percent Accuracy and Auto-Zero Feature:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Air Monitor Corporation.
  
2. Transmitter shall receive total- and static-pressure signals from a flow element, amplify signals, extract the square foot, and scale the signals to produce 4- to 20-mA dc output signals linear to airflow.
3. NEMA 250, Type 1 enclosure.
4. Construct assembly so shock, vibration, and pressures surges of up to 1 psig will neither harm transmitter, nor affect its accuracy.
5. Transmitter with automatic zeroing circuit capable of automatically readjusting transmitter zero at predetermined time intervals. The automatic zeroing circuit shall re-zero the transmitter to within 0.1 percent of true zero.
6. Performance:
  - a. Range: As required by application and at least 10 percent below minimum airflow and 10 percent greater than design airflow.
  - b. Calibrated Span: Field adjustable, minus 40 percent of the range.
  - c. Accuracy: Within 0.25 percent of natural span.
  - d. Repeatability: Within 0.15 percent of calibrated span.
  - e. Linearity: Within 0.2 percent of calibrated span.
  - f. Hysteresis and Deadband (Combined): Less than 0.2 percent of calibrated span.
  
7. Integral digital display for continuous indication of airflow.

### B. Pressure Differential Transmitters for Airflow Measurement:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Setra System.

2. Performance:
  - a. Range: As required by application and at least 10 percent below minimum airflow and 10 percent greater than design airflow.
  - b. Accuracy: Within 0.5 percent of the full-scale range.
  - c. Hysteresis: Within 0.10 percent of full scale.
  - d. Repeatability: Within 0.05 percent of full scale.
  - e. Stability: Within one percent of span per year.
  - f. Overpressure: 10 psig.
  - g. Temperature Limits: Zero to 150 deg F.
  - h. Compensate Temperature Limits: 40 to 150 deg F.
  - i. Thermal Effects: 0.033 percent of full scale per degree F.
  - j. Shock and vibration shall not harm the transmitter.
3. Output Signals:
  - a. Analog Current Signal:
    - 1) Two-wire, 4- to 20-mA dc current source.
    - 2) Signal capable of operating into 800-ohm load.
4. Display: Four-digit digital with minimum 0.4-inch-high numeric characters.
5. Operator Interface:
  - a. Zero and span adjustments located behind cover.
6. Construction:
  - a. Plastic casing with removable plastic cover.
  - b. Fittings: Swivel fittings for connection to copper tubing or barbed fittings for connection to polyethylene tubing. Fittings on bottom of instrument case.
  - c. Screw terminal block for wire connections.
  - d. Vertical plane mounting.
  - e. NEMA 250, Type 4.
  - f. Mounting Bracket: Appropriate for installation.

C. Pressure Differential Indicating Transmitter, Switch, and Controller for Airflow Measurement:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Dwyer Instruments, Inc.
2. Description:
  - a. Three-in-one instrument, including digital display, control relay switches, and a transmitter with a current output.
  - b. Field configurable for pressure, velocity, and volumetric flow applications through user interface.
  - c. Select instrument range based on application.
3. Performance:
  - a. Accuracy including hysteresis and repeatability:

- 1) Ranges Less than 5-Inch wg: Within 1 percent.
    - 2) Other Ranges: Within 0.5 percent at 77 deg F.
  - b. Stability: Within 1 percent per year.
  - c. Response Time: 250 ms.
  - d. Overpressure:
    - 1) Ranges Less than 50-Inch wg: 5 psi
    - 2) Range of 100-Inch wg: 9 psi.
  - e. Temperature Limits: 32 to 140 deg F.
  - f. Thermal Effects: 0.020 percent per deg F.
  - g. Warm-up Period: One hour.
- 4. Controller: Programming through menu keys to access five menus.
  - a. Security level.
  - b. Pressure, velocity, or flow application.
  - c. Engineering units.
  - d. K-factor for use with flow application.
  - e. Set-point control only; set-point and alarm operation; alarm operation as high, low, or high/low with manual; or automatic reset and delay.
  - f. View high and low readings.
  - g. Digital dampening for smoothing erratic applications.
  - h. Scaling of analog output to fit range and field calibration.
- 5. Display:
  - a. Four-digit digital, with minimum 0.4-inch-high alphanumeric characters.
  - b. Four LED indicators; two LEDs for set point and two LEDs for alarm status.
- 6. Operator Interface:
  - a. Set-point adjustment through keypad on face of instrument.
  - b. Zero and span adjustments accessible through menu.
  - c. Programming through keypad.
- 7. Output Analog Signal: Two-wire, 4- to 20-mA dc current source; capable of operating into a 900-ohm load.
- 8. Output Digital Signal: Two, SPDT relays; each rated for 1 A at 30-V ac or 30-V dc.
- 9. Construction:
  - a. Die-cast aluminum casing and bezel.
  - b. Connections on side and back.
  - c. Vertical plane mounting.
  - d. NEMA 250, Type 1 rating.
  - e. Nominal 4-inch-diameter face.
  - f. Mounting Bracket: Appropriate for installation.

## 2.21 LIQUID FLOW METERS

### A. Insertion Electromagnetic Flow Meter:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

- a. ONICON Incorporated.
2. Description:
    - a. No moving parts.
    - b. Suitable for flow measurement of fluids with electrical conductivity between 20 to 60000 micro-Siemens per centimeter.
    - c. Wet calibrate and tag meters to standards traceable to NIST and provide each meter with a certificate of calibration.
    - d. Continuous auto-zero function.
    - e. Transmitter integral to meter.
  3. Performance:
    - a. Flow Range: 0.25 to 20 fps.
    - b. Accuracy for Velocities between 2 and 20 fps: Within 1 percent of reading.
    - c. Accuracy for Velocities Less than 2 fps: Within 0.02 fps.
    - d. Ambient Temperature: Minus 5 to 150 deg F.
    - e. Process Temperature: 15 to 250 deg F.
    - f. Pressure: 400 psig.
  4. Output Signals:
    - a. Field-selectable analog signals.
      - 1) Current Signal (Isolated): 4 to 20 mA.
      - 2) Voltage Signal (Isolated): Zero- to 10-V dc.
    - b. Digital Signal: Dry-contact closure signaling fault condition.
    - c. Frequency Signal: Zero- to 15-V peak pulse, zero to 500 Hz.
    - d. Scalable Pulse Output:
      - 1) Isolated solid-state dry contact.
      - 2) Contact Rating: 100 mA at 50-V dc.
      - 3) Pulse Duration: 0.5, 1, 2, or 6 seconds.
  5. Construction:
    - a. Wetted Metal Parts: Type 316 stainless steel.
    - b. Sensor Head: Polysulfone.
    - c. Process Connection: 1-inch.
    - d. Instrument Isolation Valve: Full port Type 316 stainless-steel ball valve for system isolation.
    - e. Electrodes: Type 316 stainless steel.
    - f. Electronics Enclosure:
      - 1) Painted aluminum.
      - 2) Removable cover.
      - 3) NEMA 250, Type 4.
      - 4) Electrical Connection: PVC-jacketed cable, 10 feet long.
      - 5) Conduit Connection: 1/2-inch trade size.
  6. Display Module:
    - a. Remote from meter.



- b. House in a NEMA 250, Type 4X enclosure.
- c. Label terminal strip for all wiring connections.
- d. 120-V ac power supply with 24-V dc output to power the flow sensor.
- e. Input Signal from Meter: Zero- to 15-V pulse output.
- f. Output Signals: Additional output signals furnished with flow meter connected to display module terminal strip.
- g. Auxiliary Output Signals: Analog current output (isolated) shall be 4 to 20 mA.
- h. Auxiliary Output Signals: Analog voltage output (isolated) shall be zero to 10 V.
- i. Auxiliary Output Signals: Digital output (isolated) shall be solid-state dry contacts rated for 100 mA at 50 V.
- j. Digital Display:
  - 1) Flow rate.
  - 2) Totalized flow.
  - 3) At least six display digits for flow rate and eight display digits for totalization.
  - 4) Bi-directional units with separate digital display for flow and totalization in each direction.
- k. Local reset of flow totalization.
- l. Program and data shall be stored in nonvolatile memory in the event of power loss.
- m. For bi-directional units, provide LED display of flow direction (contacts open or closed).

### PART 3 - EXECUTION

#### 3.7 INSTRUMENTS, GENERAL INSTALLATION REQUIREMENTS

##### A. Mounting Location:

1. Rough-in: Outline instrument-mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
2. Install switches and transmitters for air and liquid flow associated with individual air-handling units and connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
3. Install liquid and steam flow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
4. Install airflow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
5. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
6. Install instruments in steam, liquid, and liquid-sealed-piped services below their process connection point. Slope tubing down to instrument with a slope of 2 percent.
7. Install instruments in dry gas and non-condensable-vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of 2 percent.

##### B. Mounting Height:

1. Mount instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.

2. Mount switches and transmitters, located in mechanical equipment rooms and other similar space not subject to code, state, and federal accessibility requirements, within a range of 42 to 72 inches) above the adjacent floor, grade, or service catwalk or platform.
  - a. Make every effort to mount at 60 inches.

### 3.8 FLOW INSTRUMENTS INSTALLATION

#### A. Airflow Sensors:

1. Install sensors in straight sections of duct with manufacturer-recommended straight duct upstream and downstream of sensor.
2. Installed sensors shall be accessible for visual inspection and service. Install access door(s) in duct or equipment located upstream of sensor, to allow service personnel to hand clean sensors.

#### B. Liquid Flow Meters:

1. Install meters in straight sections of piping with manufacturer-recommended straight piping upstream and downstream of sensor.
2. Install pipe reducers for in-line meters smaller than line size. Install reducers at distance from meter to avoid interference and impact on accuracy.
3. Install in-line meters with flanges or unions to provide drop-in and -out installation.
4. Insertion Meters:
  - a. Install system process connections full size of meter connection, but not less than pipe size. Provide stainless-steel bushing if required to mate to system connection.
  - b. Install meter in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement.
  - c. In applications where top-dead-center location is not possible due to field constraints, install meter at location along top half of pipe if acceptable by manufacturer for mounting orientation.

#### C. Transmitters:

1. Install airflow transmitters serving an air system in a single location adjacent to or within system control panel.
2. Install liquid flow transmitters, not integral to sensors, in vicinity of sensor. Where multiple flow transmitters serving same system are located in same room, co-locate transmitters by system to provide service personnel a single and convenient location for inspection and service.

### 3.14 INSTRUMENT APPLICATIONS

- #### A. Select from instrument types to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.

#### B. Duct-Mounted Airflow Sensors:

1. Measured Velocities 500 fpm and Less: Thermal airflow station.
2. Measured Velocities Greater than 500 fpm: Thermal airflow station.

#### C. Damper-Mounted Airflow Sensors:

1. Measured Velocities 500 fpm and Less: Thermal airflow station.

2. Measured Velocities Greater than 500 fpm: Thermal airflow station.

D. Fan-Mounted Airflow Sensors:

1. Piezometer ring fan inlet airflow sensor.

E. Airflow Switches:

1. Measured Velocities 400 fpm and Less: Polymer film sail switch.

2. Measured Velocities Greater than 400 fpm: Stainless-steel single-vane switch.

F. Liquid Flow Meters:

1. Domestic Water System: Electromagnetic flow meter.

END OF SECTION

## SECTION 230910.16

### GAS INSTRUMENTS

#### PART 1 - GENERAL

##### 1.1 STIPUMATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section Includes the Following Gas Instruments:
  - 1. Carbon-dioxide sensors and transmitters.
- B. Related Requirements:
  - 1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
  - 2. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section 230923.11.

##### 1.4 DEFINITIONS

- A. NDIR: Nondispersive infrared.

##### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product, including the following:
  - 1. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
  - 2. Installation instructions, including factor affecting performance.
  - 3. Product description with complete technical data, performance curves, product specification sheets.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and mounting details.
  - 2. Include diagrams for power, signal, and control wiring.
  - 3. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

- C. Samples: For each exposed product installed in finished space.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which wall-mounted instruments located in finished space are shown and coordinated with each other, showing relationship to light switches, fire alarm devices, and other installed devices using input from installers of the items involved.
- B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For gas instruments to include in operation and maintenance manuals.

### PART 2 - PRODUCTS

#### 2.1 CARBON-DIOXIDE SENSORS AND TRANSMITTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Building Automation Products Inc.; BAPI.
  - 2. Telaire; a brand of Amphenol Thermometrics Inc.
  - 3. Vaisala.
  - 4. Veris Industries.
- B. Description:
  - 1. NDIR technology or equivalent technology providing long-term stability and reliability.
  - 2. Two-wire, 4-20 mA output signal, linearized to carbon-dioxide concentration in ppm.
- C. Construction:
  - 1. House electronics in an ABS plastic enclosure. Provide equivalent of NEMA 250, Type 1 enclosure for wall-mounted space applications and NEMA 250, Type 4 for duct-mounted applications.
  - 2. Equip with digital display for continuous indication of carbon-dioxide concentration.
- D. Performance:
  - 1. Measurement Range: Zero to 2000 ppm.
  - 2. Accuracy: Within 2 percent of reading, plus or minus 30 ppm.
  - 3. Repeatability: Within 1 percent of full scale.
  - 4. Temperature Dependence: Within 0.05 percent of full scale over an operating range of 25 to 110 deg F.
  - 5. Long-Term Stability: Within 5 percent of full scale after more than five years.
  - 6. Response Time: Within 60 seconds.
  - 7. Warm-up Time: Within five minutes.
- E. Provide calibration kit. Turn over to Owner at start of warranty period.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
- C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION, GENERAL

- A. Furnish and install products required to satisfy more stringent of all requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Properly support instruments, tubing, piping, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to seismic loads.
- D. Fastening Hardware:
  - 1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
  - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by using excessive force or oversized wrenches.
  - 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- E. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

### 3.3 ELECTRICAL POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with the requirements in the electrical division section of the specifications.
- C. Furnish and install power wiring. Comply with the requirements in the electrical division section of the specifications.
- D. Furnish and install raceways. Comply with the requirements in the electrical division section of the specifications.

### 3.4 INSTRUMENTS, GENERAL INSTALLATION REQUIREMENTS

- A. Mounting Location:

1. Install transmitters for gas associated with individual air-handling units and associated connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
2. Install gas switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
3. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer's mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
4. Install instruments in dry gas and non-condensable vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of 2 percent.

B. Mounting Height:

1. Mount instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.
2. Mount switches and transmitters located in mechanical equipment rooms and other similar space not subject to code, state, and federal accessibility requirements within a range of 42 to 72 inches above the adjacent floor, grade, or service catwalk or platform.
  - a. Make every effort to mount at 60 inches.

- C. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated, using neoprene gaskets or grommets.

### 3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification in the electrical division of the specifications.
- B. Install engraved phenolic nameplate with instrument identification on face.

### 3.6 CHECKOUT PROCEDURES

- A. Check out installed products before continuity tests, leak tests, and calibration.
- B. Check instruments for proper location and accessibility.
- C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that impact performance.
- D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

### 3.7 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.

2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, perform a three-point calibration test for both linearity and accuracy.
4. Equipment and procedures used for calibration shall comply with instrument manufacturer's written recommendations.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments shall have an accuracy of at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If, after calibration, indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures in ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Meters: Check sensors at zero, 50, and 100 percent of Project design values.

E. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

F. Switches: Calibrate switches to make or break contact at set points indicated.

G. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.

### 3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.
- B. Coordinate gas instrument demonstration video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.
- C. Record videos on DVD disks.



- D. Owner shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION

## SECTION 230910.17

### LEVEL INSTRUMENTS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section includes liquid-level switches, sensors, and transmitters.
- B. Related Requirements:
  - 1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
  - 2. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section 230923.11.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include operating characteristics; electrical characteristics; and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
  - 2. Include product description with complete technical data, performance curves, and product specification sheets.
- B. Shop Drawings:
  - 1. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Include diagrams for power, signal, and control wiring.
  - 3. Include number-coded identification system for unique identification of wiring, cable, and tubing ends.

##### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For level instruments, to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 LEVEL SWITCHES

#### A. Liquid-Level Switch (Magnetic Type with Float):

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. W. E. Anderson; Dwyer Instruments, Inc.
2. Description:
  - a. Mounting Suitable for Application: Horizontal or vertical switch mounting.
  - b. Float arm with hinge design limits vertical movement to prevent sticking.
  - c. Replaceable float with threaded connection.
  - d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for hazardous environments (Class I, Groups C and D; Class II, Groups E, F, and G).
3. Performance:
  - a. Level Actuation and De-Actuation: 0.75-inch dead-band.
  - b. Body Pressure Limit: 1000 psig for brass body; 2000 psig for Type 316 stainless-steel body.
  - c. Float Pressure Limit: 150 psig.
  - d. Temperature Range: Minus 4 to 275 deg F.
  - e. Electrical Rating: 10 A at 125/250-V ac.
  - f. Switch Type: SPDT snap switch.
4. Wetted Parts Construction:
  - a. Float and Rod: Type 316 stainless steel.
  - b. Body: Brass.
  - c. Magnetic Keeper: Type 316 stainless steel.
  - d. Process Connection: NPS 1-1/2 NPT.
  - e. Enclosure:
    - 1) Die-cast aluminum alloy.
    - 2) Threaded cover.
    - 3) NEMA 250, Type 4.
    - 4) Electrical Connection: Terminal block.
    - 5) Conduit Connection: NPS 3/4 NPT.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for instruments to verify actual locations of connections before installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION, GENERAL

- A. Install products level, plumb, parallel, and perpendicular with building construction.
- B. Properly support instruments, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement, sway, or a break in attachment when subjected to a <Insert value> force.
- C. Fastening Hardware:
  - 1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
  - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by using excessive force or oversized wrenches.
  - 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- D. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.
- E. Mount switches and transmitters not subject to code, state, and federal accessibility requirements within a range of 42 to 72 inches above the adjacent floor, grade or service catwalk, or platform.
  - 1. Make every effort to mount at 60 inches.

### 3.3 ELECTRICAL POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with the requirements of the electrical division of the specifications.
- D. Furnish and install raceways. Comply with requirements in of the electrical division of the specifications.

### 3.4 LEVEL INSTRUMENTS INSTALLATION

- A. Mounting Location: Rough-in instrument-mounting locations before setting instruments and routing, cable, wiring, tubing, and conduit to final location.

### 3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install engraved phenolic nameplate with instrument identification on face.

### 3.6 CHECKOUT PROCEDURES

- A. Check out installed products before continuity tests, leak tests, and calibration.
- B. Check instruments for proper location and accessibility.
- C. Check instruments for proper installation on direction of elevation, orientation, insertion depth, or other applicable considerations that impact performance.

### 3.7 ADJUSTMENT, CALIBRATION, AND TESTING

#### A. Description:

- 1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
- 2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
- 3. For each analog instrument, perform a three-point calibration test for both linearity and accuracy.
- 4. Equipment and procedures used for calibration shall comply with instrument manufacturer's written recommendations.
- 5. Provide diagnostic and test equipment for calibration and adjustment.
- 6. Field instruments and equipment used to test and calibrate installed instruments shall have an accuracy of at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
- 7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
- 8. If, after calibration, indicated performance cannot be achieved, replace out-of-tolerance instruments.
- 9. Comply with field-testing requirements and procedures in ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.

#### B. Analog Signals:

- 1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
- 2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
- 3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

#### C. Digital Signals:

- 1. Check digital signals using a jumper wire.
- 2. Check digital signals using an ohmmeter to test for contact.

#### D. Switches: Calibrate switches to make or break contact at setpoints indicated.

#### E. Transmitters:

- 1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
- 2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.
- B. Coordinate level instrument demonstration video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.
- C. Record videos on DVD disks.
- D. Owner shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION

## SECTION 230923

### DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

#### PART 1 – GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section Includes:

- 1. DDC system for monitoring and controlling of HVAC systems.
- 2. Delivery of selected control devices to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation.

- B. Related Requirements:

- 1. Section 230993 "Sequence of Operations for HVAC DDC" for control sequences.

##### 1.4 DEFINITIONS

- A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.

- B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

- C. BACnet Specific Definitions:

- 1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data over and services over a network.
- 2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
- 3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
- 4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.
- 5. PICS (Protocol Implementation Conformance Statement): Written document that identifies the particular options specified by BACnet that are implemented in a device.

- D. BAS: Building Automation System.

- E. BMS: Building Management System.

- F. Binary: Two-state signal where a high signal level represents "ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.
- G. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: Network Controller, Programmable Application Controller, and Application-Specific Controller.
- H. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing of enterprise system.
- I. COV: Changes of value.
- J. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.
- K. Distributed Control: Processing of system data is de-centralized and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems shall be capable of operating in a standalone mode using the last best available data.
- L. DOCSIS: Data-Over Cable Service Interface Specifications.
- M. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.
- N. HLC: Heavy load conditions.
- O. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.
- P. LAN: Local area network.
- Q. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- R. Modbus TCP/IP: An open protocol for exchange of process data.
- S. MS/TP: Master-slave/token-passing, IEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.
- T. MTBF: Mean time between failures.
- U. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers that communicates on peer-to-peer network for transmission of global data.
- V. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.
- W. PDA: Personal digital assistant.



- X. Peer to Peer: Networking architecture that treats all network stations as equal partners.
- Y. POT: Portable operator's terminal.
- Z. RAM: Random access memory.
- AA. RF: Radio frequency.
- BB. Router: Device connecting two or more networks at network layer.
- CC. Server: Computer used to maintain system configuration, historical and programming database.
- DD. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
- EE. UPS: Uninterruptible power supply.
- FF. USB: Universal Serial Bus.
- GG. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.
- HH. VAV: Variable air volume.
- II. WLED: White light emitting diode.

#### 1.4 ACTION SUBMITTALS

##### A. Multiple Submissions:

1. If multiple submissions are required to execute work within schedule, first submit a coordinated schedule clearly defining intent of multiple submissions. Include a proposed date of each submission with a detailed description of submittal content to be included in each submission.
2. Clearly identify each submittal requirement indicated and in which submission the information will be provided.
3. Include an updated schedule in each subsequent submission with changes highlighted to easily track the changes made to previous submitted schedule.

##### B. Product Data: For each type of product include the following:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation and maintenance instructions including factors effecting performance.
5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product. Including but not limited to:
  - a. Operator workstation.

- b. Gateways.
  - c. DDC controllers.
  - d. Enclosures.
  - e. Electrical power devices.
  - f. Accessories.
  - g. Instruments.
  - h. Control dampers and actuators.
  - i. Temperature sensors and T-Stats.
6. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
  7. Each submitted piece of product literature shall clearly cross reference specification and drawings that submittal is to cover.
  8. Supporting documentation showing DDC system design complies with performance requirements indicated, including calculations and other documentation necessary to prove compliance.
  9. Schedule and design calculations for control dampers and actuators.
    - a. Flow at Project design and minimum flow conditions.
    - b. Face velocity at Project design and minimum airflow conditions.
    - c. Pressure drop across damper at Project design and minimum airflow conditions.
    - d. AMCA 500-D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
    - e. Maximum close-off pressure.
    - f. Leakage airflow at maximum system pressure differential (fan close-off pressure).
    - g. Torque required at worst case condition for sizing actuator.
    - h. Actuator selection indicating torque provided.
    - i. Actuator signal to control damper (on, close or modulate).
    - j. Actuator position on loss of power.
    - k. Actuator position on loss of control signal.
  10. Schedule and design calculations for selecting flow instruments.
    - a. Instrument flow range.
    - b. Project design and minimum flow conditions with corresponding accuracy, control signal to transmitter and output signal for remote control.
    - c. Extreme points of extended flow range with corresponding accuracy, control signal to transmitter and output signal for remote control.
    - d. Pressure-differential loss across instrument at Project design flow conditions.
    - e. Where flow sensors are mated with pressure transmitters, provide information for each instrument separately and as an operating pair.

C. Software Submittal:

1. Cross-referenced listing of software to be loaded on operator workstation, server, gateway, and DDC controller.
2. Description and technical data of all software provided and cross-referenced to products in which software will be installed.
3. Operating system software, operator interface and programming software, color graphic software, DDC controller software, maintenance management software, and third-party software.
4. Include a flow diagram and an outline of each subroutine that indicates each program variable name and units of measure.
5. Description of system database, including all data included in database, database capacity and limitations to expand database.

6. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

D. Shop Drawings:

1. General Requirements:
  - a. Include cover drawing with Project name, location, Owner, Engineer, Contractor, and issue date with each Shop Drawings submission.
  - b. Include a drawing index sheet listing each drawing number and title that matches information in each title block.
  - c. Prepare Drawings using CAD.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Plan Drawings indicating the following:
  - a. Screened backgrounds of walls, structural grid lines, HVAC equipment, ductwork, and piping.
  - b. Room names and numbers with coordinated placement to avoid interference with control products indicated.
  - c. Operator workstation, server, gateway, router, DDC controller, control panel instrument connecting to DDC controller and damper connecting to DDC controller.
  - d. Exact placement of products in rooms, ducts, and piping to reflect proposed installed condition.
  - e. Network communication cable and raceway routing.
  - f. Proposed routing of wiring, cabling, and conduit, coordinated with building services for review before installation.
4. Schematic drawings for each controlled HVAC system indicating the following:
  - a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper, if included in Project.
  - b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.
  - c. A graphic showing location of control I/O in proper relationship to HVAC system.
  - d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
  - e. Unique identification of each I/O that shall be consistently used between different drawings showing same point.
  - f. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays, and interface to DDC controllers.
  - g. Narrative sequence of operation.
  - h. Graphic sequence of operation, showing all inputs and output logical blocks.
5. Control panel drawings indicating the following:
  - a. Panel dimensions, materials, size, and location of field cable and raceways connections.
  - b. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates and allocated spare space.
  - c. Front, rear, and side elevations and nameplate legend.

- d. Unique drawing for each panel.
6. DDC system network riser diagram indicating the following:
    - a. Connections points into the DDC System.
    - b. Each device connected to network with unique identification for each.
    - c. Interconnection of each different network in DDC system.
    - d. For each network, indicate communication protocol, speed, and physical means of interconnecting network devices, such as copper cable type, or fiber-optic cable type. Indicate raceway type and size for each.
    - e. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.
  7. DDC system electrical power riser diagram indicating the following:
    - a. Each point of connection to field power with requirements (volts/phase/hertz/amperes/connection type) listed for each.
    - b. Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
    - c. Each product requiring power with requirements (volts/phase/hertz/amperes/connection type) listed for each.
    - d. Power wiring type and size, race type, and size for each.
  8. Color graphics indicating the following:
    - a. Itemized list of color graphic displays to be provided.
    - b. For each display screen to be provided, a true color copy showing layout of pictures, graphics and data displayed.
    - c. Intended operator access between related hierarchical display screens.
- E. System Description:
1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies.
  2. Complete listing and description of each report, log and trend for format and timing and events which initiate generation.
  3. System and product operation under each potential failure condition including, but not limited to, the following:
    - a. Loss of power.
    - b. Loss of network communication signal.
    - c. Loss of controller signals to inputs and outputs.
    - d. Operator workstation failure.
    - e. Server failure.
    - f. Gateway failure.
    - g. Network failure
    - h. Controller failure.
    - i. Instrument failure.
    - j. Control damper actuator failure.
    - k. Temperature sensor failure.
  4. Complete bibliography of documentation and media to be delivered to Owner.
  5. Description of testing plans and procedures.

6. Description of Owner training.

## 1.5 INFORMATIONAL SUBMITTALS

### A. Qualification Data:

1. Manufacturer's qualification data.
2. Testing agency's qualifications data.

B. Product Test Reports: For each product that requires testing to be performed by a qualified testing agency.

C. Preconstruction Test Reports: For each separate test performed.

D. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For DDC system to include in emergency, operation and maintenance manuals.

1. In addition to items specified in Division 1 "Operation and Maintenance Data," include the following:
  - a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
  - b. Testing reports and checklists of completed final versions of reports, checklists, and trend logs.
  - c. As-built versions of submittal Product Data.
  - d. Names, addresses, e-mail addresses and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
  - e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control and changing set points and variables.
  - f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
  - g. Engineering, installation, and maintenance manuals that explain how to:
    - 1) Design and install new points, panels, and other hardware.
    - 2) Perform preventive maintenance and calibration.
    - 3) Debug hardware problems.
    - 4) Repair or replace hardware.
  - h. Backup copy of graphic files, programs, and database on electronic media such as flash drives.
  - i. List of recommended spare parts with part numbers and suppliers.
  - j. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
  - k. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
  - l. Licenses, guarantees, and warranty documents.

- m. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
- n. Owner training materials.

## 1.7 QUALITY ASSURANCE

### A. DDC System Provider Qualifications:

- 1. Authorized representative of, and trained by, DDC system manufacturer.
- 2. Demonstrated past experience with installation of DDC system products being installed for period within five consecutive years before time of bid.
- 3. Each person assigned to Project shall have demonstrated past experience.
- 4. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
- 5. Service and maintenance staff assigned to support Project during warranty period.
- 6. Product parts inventory to support on-going DDC system operation for a period of not less than 5 years after Substantial Completion.

## 1.8 WARRANTY

### A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.

- 1. Failures shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
- 2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies.
  - a. Install updates only after receiving Owner's written authorization.
- 3. Warranty service shall occur during normal business hours and commence within 24 hours of Owner's warranty service request.
- 4. Warranty Period: Two years from date of Substantial Completion.

## PART 2 – PRODUCTS

### 2.1 MANUFACTURERS

#### A. Approved manufacturers/systems subject to compliance with the requirements shall be one of the following:

- 1. Johnson Controls
- 2. Distech
- 3. Siemens
- 4. Honeywell
- 5. Schneider Electric

### 2.2 DDC SYSTEM DESCRIPTION

#### A. Microprocessor-based monitoring and control including analog/digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.

1. DDC system shall consist of a high-speed, peer-to-peer network of distributed DDC controllers, other network devices, operator interfaces, and software.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.3 WEB ACCESS

- A. DDC system shall be Web compatible.
1. Web-Compatible Access to DDC System:
    - a. Operator workstation and server shall perform overall system supervision and configuration, graphical user interface, management report generation, and alarm annunciation.
    - b. DDC system shall support Web browser access to building data. Operator using a standard Web browser shall be able to access control graphics and change adjustable set points.
    - c. Web access shall be password protected.
    - d. Workstation may be Thin Client or WYSE terminal
    - e. Provide Wireless access point in all electrical and mechanical rooms. Coordinate with owner or IT vendor/designer.
    - f. Wireless access shall support smart tablets and phones.

## 2.4 PERFORMANCE REQUIREMENTS

- A. System Performance Objectives:
1. DDC system shall manage HVAC systems.
  2. DDC system control shall operate HVAC systems to achieve optimum operating costs while using least possible energy and maintaining specified performance.
  3. DDC system shall respond to power failures, HVAC equipment failures, and adverse and emergency conditions encountered through connected I/O points.
  4. DDC system shall operate while unattended by an operator and through operator interaction.
  5. DDC system shall record trends and transaction of events and produce report information such as performance, energy, occupancies, and equipment operation.
- B. Surface-Burning Characteristics: Products installed in ducts, equipment, and return-air paths shall comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame-Spread Index: 25 or less.
  2. Smoke-Developed Index: 50 or less.
- C. Network Bandwidth: Design each network of DDC system to include at least 30 percent available spare bandwidth with DDC system operating under normal and heavy load conditions indicated. Calculate bandwidth usage and apply a safety factor to ensure that requirement is satisfied when subjected to testing under worst case conditions.
- D. DDC System Data Storage:
1. Include server(s) with disk drive data storage to archive not less than 24 consecutive months of historical data for all I/O points connected to system, including alarms, event histories, transaction logs, trends and other information indicated.

2. When logged onto a server, operator shall be able to also interact with any DDC controller connected to DDC system as required for functional operation of DDC system.
3. Server(s) shall be used for application configuration; for archiving, reporting and trending of data; for operator transaction archiving and reporting; for network information management; for alarm annunciation; and for operator interface tasks and controls application management.
4. Server(s) shall use IT industry-standard database platforms such as Microsoft SQL Server and Microsoft Data Engine (MSDE).

E. Future Expandability:

1. DDC system size shall be expandable to an ultimate capacity of at least 25% of total I/O points indicated.
2. Additional DDC controllers, I/O and associated wiring shall be all that is needed to achieve ultimate capacity. Initial network infrastructure shall be designed and installed to support ultimate capacity.
3. Operator interfaces installed initially shall not require hardware and software additions and revisions for ultimate capacity.

F. Input Point Displayed Accuracy: Input point displayed values shall meet following end-to-end overall system accuracy, including errors associated with meter, sensor, transmitter, lead wire or cable, and analog to digital conversion.

1. Energy:

- a. Thermal: Within 3 percent of reading.
- b. Electric Power: Within 1 percent of reading.
- c. Requirements indicated on Drawings for meters not supplied by utility.

2. Flow:

- a. Air: Within 2 percent of design flow rate.

3. Moisture (Relative Humidity):

- a. Air: Within 5 percent RH.
- b. Space: Within 5 percent RH.
- c. Outdoor: Within 5 percent RH.

4. Pressure:

- a. Air, Ducts and Equipment: 1 percent of instrument span.

5. Speed: Within 5 percent of reading.

6. Temperature (Dry Bulb, Wet Bulb and Dew Point):

- a. Air: Within 1 deg F.
- b. Space: Within 1 deg F.
- c. Outdoor: Within 2 deg F.

G. Performance Standards: System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for operator workstation (server and browser for web-based systems).



1. Graphic Display: A graphic with 20 dynamic points shall display with current data within 10 sec.
  2. Graphic Refresh: A graphic with 20 dynamic points shall update with current data within 8 sec. and shall automatically refresh every 15 sec.
  3. Configuration and Tuning Screens: Screens used for configuring, calibrating, or tuning points, control loops, and similar control logic shall automatically refresh with 6 sec.
  4. Alarm Response Time: An object that goes into alarm shall be annunciated at the workstation within 15 sec.
  5. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every 5 sec. Select execution times consistent with the mechanical process under control.
  6. Performance: Programmable controllers shall be able to completely execute DDC SYSTEM control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
  7. Multiple Alarm Annunciations: Each workstation on the network shall receive alarms within 5 sec. of other workstations.
- H. Data Base Update: Under normal system operation, the Workstation Equipment point data base shall be updated so that any change in analog value or digital status is no older than ten (10) seconds
- I. Environmental Conditions for Controllers, Gateways, and Routers:
1. Products shall operate without performance degradation under ambient environmental temperature, pressure and humidity conditions encountered for installed location.
    - a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated as required by product and application.
  2. Products shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Products not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:
    - a. Outdoors, Protected: Type 3.
    - b. Outdoors, Unprotected: Type 4.
    - c. Indoors, Heated with Ventilation: Type 2.
    - d. Indoors, Heated and Air Conditioned: Type 1.
    - e. Mechanical Equipment Rooms: Type 4
    - f. Within Duct Systems and Air-Moving Equipment: Type 4.
- J. Backup Power Source:
1. HVAC systems and equipment served by a backup power source shall have associated DDC system products that control such systems and equipment also served from a backup power source.
- K. UPS:
1. Power the following DDC system products by UPS units:
    - a. Operator workstation.

- b. Printer.
- c. Server.
- d. Gateways.
- e. DDC controllers.

L. Continuity of Operation after Electric Power Interruption:

1. Automatic Restart: Entire DDC System shall have automatic restart software that causes system to actuate automatic restart without human intervention after an electrical power outage and UPS battery drain and subsequent restart.
  - a. Workstation Equipment Power Failure: During normal operation, each workstation shall continuously update all system information on its own hard drive. Provide safeguard procedures to assure that any interruptions of power during the updating procedure will not destroy memory record of any data file already on the drive. During each update procedure, a time tag shall be stored in a file with current month, day, hour, and minute. At time of power failure at workstation equipment, all workstation equipment shall go through an orderly shutdown such that no system information and/or programming information is destroyed or lost. Upon power restoration after a power failure, each workstation shall restart. Power failure at workstation equipment shall not affect control functions of BCU(s).
  - b. DDC System Power Failure: Provide safeguard procedures to assure that any interruptions of power during operation of DDC System will not cause a loss of any programming information and/or stored database information from input devices. At the time of power failure at DDC System all functions of DDC System shall shutdown orderly (and without damaging any connected equipment) such that all connected equipment shall either be positioned to "Fail Safe" mode or be de-energized and cease to operate. Upon power restoration and after a power failure, DDC System shall generate an automatic restart command which shall cause DDC System to restart, and DDC System shall automatically restart and DDC System shall automatically restart corresponding software, including adjustment of all optimum start-stop and schedule start-stop programs. DDC System shall review all programs that should have been executed during power failure and shall energize appropriate equipment sequentially. DDC System shall resort each point to proper state as if power failure has not occurred (except for update of current time and date). All major electrical loads shall be sequentially restarted with adjustable time delays.

M. Power Line Surge Protection: Protect equipment power supplies from power line surges to 1000 V ac rms. Provide protection of equipment at ground potential to ensure protection against surges. Transient surge protection shall be incorporated into design/manufacture of each RCP/ASC/TCU and operator's workstation to protect electrical components. Do not use fuses for surge protection.

N. Communication Links Surge Protection: Protect communications equipment against surges induced on any communications link to 1000 V ac rms. Cables and conductors which serve as communications links between BAS OWS, Servers, Network Controllers and Remote-Control Panels shall have surge protection circuits installed at each end. Do not use fuses for surge protection.

## 2.5 DDC SYSTEM OPERATOR INTERFACES

A. Operator Means of System Access: Operator shall be able to access entire DDC system through any of multiple means, including, but not limited to, the following:

1. Desktop and portable operator workstation with hardwired connection through LAN port.
  2. Remote connection using outside of system personal computer or PDA through Web access.
  3. Remote connection using portable operator workstation and modem.
- B. Access to system, regardless of operator means used, shall be transparent to operator.
- C. Network Ports: For hardwired connection of desktop or portable operator workstation. Network port shall be easily accessible, properly protected, clearly labeled, and installed at the following locations:
1. MDF Room.
- D. Desktop Workstation:
1. Connect to DDC system LAN through a communications port directly on LAN or through a communications port on a DDC controller.
  2. Able to communicate with any device located on any DDC system LAN.
  3. Able to communicate, with modems, remotely with any device connected to any DDC system LAN.
  4. Communication via a modem shall not interfere with LAN activity and LAN activity shall not prevent workstation from handling incoming calls.
- E. Portable Workstations:
1. Connect to DDC system Level one LAN through a communications port directly on LAN or through a communications port on a DDC controller.
  2. Able to communicate with any device located on any DDC system LAN.
  3. Connect to DDC system LAN through a communications port on an application-specific controller, or a room temperature sensor connected to an application-specific controller.
  4. Portable workstation shall be able to communicate with any device connected to any system LAN regardless of point of physical connection to system.
  5. Monitor, program, schedule, adjust set points, and report capabilities of I/O connected anywhere in system.
  6. Have dynamic graphic displays that are identical to desktop workstations.
- F. POT:
1. Connect DDC controller through a communications port local to controller.
  2. Able to communicate with any DDC system controller that is directly connected to DDC system.
- G. Telephone Communications:
1. Through use of a standard modem, operator shall be able to communicate with any device connected to any system LAN.
  2. Have auto-dial and auto-answer communications to allow desktop and portable workstations and DDC controllers to communicate with remote workstations and remote DDC controllers via telephone lines.
    - a. Desktop and Portable Operator Workstation Computers with Modems:
      - 1) Operators shall be able to perform all control functions, report functions, and database generation and modification functions as if directly connected to system LAN.

- 2) Have routines to automatically answer calls, and either file or display information sent remotely.
- 3) Communications taking place over telephone lines shall be completely transparent to operator.
- 4) Dial-up program shall maintain a user-definable cross-reference and associated telephone numbers, so it is not required to remember or manually dial telephone numbers.

b. DDC Controllers:

- 1) Not have modems unless specifically indicated for a unique controller.
- 2) Analyze and prioritize alarms to minimize initiation of calls.
- 3) Buffer noncritical alarms in memory and report them as a group of alarms, or until an operator manually requests an upload.
- 4) Make provisions for handling busy signals, no-answers, and incomplete data transfers.
- 5) Call default devices when communications cannot be established with primary devices.

H. Critical Alarm Reporting:

1. Operator-selected critical alarms shall be sent by DDC system to notify operator of critical alarms that require immediate attention.
2. DDC system shall send alarm notification to multiple recipients that are assigned for each alarm.
3. DDC system shall notify recipients by any or all means, including e-mail, text message and prerecorded phone message to mobile and landline phone numbers.

I. Simultaneous Operator Use: Capable of accommodating up to five simultaneous operators that are accessing DDC system through any one of operator interfaces indicated.

2.6 NETWORKS

A. Acceptable networks for connecting operator workstations and network controllers include the following:

1. IP.
2. IEEE 8802-3, Ethernet.

B. Acceptable networks for connecting programmable application controllers include the following:

1. IP.
2. IEEE 8802-3, Ethernet.

C. Acceptable networks for connecting application-specific controllers include the following:

1. IP.
2. IEEE 8802-3, Ethernet.

2.7 NETWORK COMMUNICATION PROTOCOL

A. Network communication protocol(s) used throughout entire DDC system shall be open to public and available to other companies for use in making future modifications to DDC system.

B. ASHRAE 135 Protocol:

1. ASHRAE 135 communication protocol shall be sole and native protocol used throughout entire DDC system.
2. DDC system shall not require use of gateways except to integrate HVAC equipment and other building systems and equipment, not required to use ASHRAE 135 communication protocol.
3. If used, gateways shall connect to DDC system using ASHRAE 135 communication protocol and Project object properties and read/write services indicated by interoperability schedule.
4. Operator workstations, controllers and other network devices shall be tested and listed by BACnet Testing Laboratories.

C. Industry Standard Protocols:

1. DDC system shall use any one or a combination of the following industry standard protocols for network communication while complying with other DDC system requirements indicated:
  - a. ASHRAE 135.
2. Operator workstations and network controllers shall communicate through ASHRAE 135 protocol.
3. Portions of DDC system networks using ASHRAE 135 communication protocol shall be an open implementation of network devices complying with ASHRAE 135. Network devices shall be tested and listed by BACnet Testing Laboratories.
4. Portions of DDC system networks using Modbus Application Protocol Specification V1.1b communication protocol shall be an open implementation of network devices and technology complying with Modbus Application Protocol Specification V1.1b.
5. Gateways shall be used to connect networks and network devices using different protocols.

## 2.9 DESKTOP OPERATOR WORKSTATIONS

A. Performance Requirements:

1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. Energy Star compliant.

B. Personal Computer:

1. Minimum Processor Speed: 3.3 gigahertz.
2. RAM:
  - a. Capacity: 24 GB.
  - b. Expandable Capacity: 24 GB.
3. Hard Drive:
  - a. Number of Hard Drives: Two.
  - b. Capacity: 1 TB each.
4. Optical Read and Write Drive:
  - a. Include with at least 2 MB of data buffer.
  - b. Type: HD.

- c. Average access time of 150 ms or less.
    - d. MTBF of at least 100,000 power-on hours.
  - 5. At least four expansion slots of 64 bit.
  - 6. Video Card:
    - a. Resolution: 1920 by 1200 pixels.
    - b. RAM: 8 GB.
  - 7. Sound Card:
    - a. At least 128 voice wavetable synthesis.
    - b. Capable of delivering three-dimensional sound effects.
    - c. High-resolution 16-bit stereo digital audio recording and playback with user-selectable sample rates up to 48,000 Hz.
  - 8. Network Interface Card: Include card with connection, as applicable.
    - a. 10-100-1000 base TX Ethernet with RJ45 connector port.
    - b. 100 base FX Ethernet with SC or ST port.
  - 9. Modem:
    - a. Ethernet connectivity.
  - 10. I/O Ports:
    - a. Two USB 3.0 ports on front panel, six on back panel, and three internal on motherboard.
    - b. One serial port.
    - c. One parallel port.
    - d. Two PS/2 ports.
    - e. One RJ-45.
    - f. One stereo line-in and headphone line-out on back panel.
    - g. One microphone and headphone connector on front panel.
    - h. One IEEE 1394 on front and back panel with PCI-e card.
    - i. One ESATA port on back panel.
  - 11. Battery: Life of at least three years to maintain system clock/calendar and ROM, as a minimum.
- C. Keyboard:
- 1. 101 enhanced keyboard.
  - 2. Full upper- and lowercase ASCII keyset, numeric keypad, dedicated cursor control keypad, and 12 programmable function keys.
  - 3. Wireless operation within up to 72 inches in front of workstation.
- D. Pointing Device:
- 1. Either a two- or three-button mouse.
  - 2. Wireless operation within up to 72 inches in front of workstation.
- E. Flat Panel Display Monitor:

1. Display:
  - a. Color display with 21 inches diagonal viewable area.
  - b. Digital or analog input signal.
  - c. Aspect Ratio: 16 to 9.
  - d. Antiglare display.
  - e. Dynamic Contrast Ratio: 50000 to 1.
  - f. Tilt adjustable base.
  - g. Energy Star compliant.
  - h. Resolution: 1920 by 1080 pixels at 60 Hz with pixel size of 0.277 mm or smaller.
  - i. Number of Displays: One.

F. Speakers:

1. Two, with individual controls for volume, bass and treble.
2. Signal to Noise Ratio: At least 65 dB.
3. Power: At least 4 W per speaker/channel.
4. Magnetic shielding to prevent distortion on the video monitor.

G. I/O Cabling: Include applicable cabling to connect I/O devices.

## 2.10 SERVERS

A. Performance Requirements:

1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. Energy Star compliant.
3. Minimum Processor Speed: 3.3 gigahertz.
4. RAM:
  - a. Capacity: 24GB.
  - b. Expandable Capacity: 24 GB.
5. Redundant Array of Independent Disks: Two configuration.
6. Drive Bays: Eight at 2.5 inches or eight at 3.5 inches.
7. Hard-Drive Storage: Three drives each with 2 TB storage and nominal rotational speed of 7200 rpm.
8. Network Interface: Dual port Ethernet.
9. DVD +RW Drive.
10. Keyboard and mouse.
11. Next-day on-site warranty for two-year period following Substantial Completion.

B. Servers shall include the following:

1. Full-feature backup server (server and backup minimum requirement).
2. Software licenses.
3. CAT-6 cable installation between server(s) and network.

C. Web Server:

1. If required to be separate, include Web server hardware and software to match, except backup server is not required.
2. Firewalls between server Web and networks.
3. Password protection for access to server from Web server.

4. CAT 6 cable installation between the server(s) and building Ethernet network.

D. Power each server through a 3,000 VA UPS unit.

## 2.11 PRINTER

A. Color Laser Printer:

1. 1200 by 1200 dots per inch resolution black and white, 1200 by 1200 dots per inch resolution black and white and color.
2. First sheet printed within 10 seconds.
3. Print buffer with at least 512 MB of RAM, expandable to at least one GB.
4. Complies with Energy Star requirements.
5. Capable of handling letter, legal, and tabloid (11x17) size paper.
6. Two paper trays;
7. Two-sided printing.

## 2.12 SYSTEM SOFTWARE

A. System Software Minimum Requirements:

1. Real-time multitasking and multiuser 64-bit operating system that allows concurrent execution of multiple real-time programs and custom program development.
2. Operating system shall be capable of operating Microsoft Windows applications.
3. Database management software shall manage all data on an integrated and non-redundant basis. Additions and deletions to database shall be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
4. Network communications software shall manage and control multiple network communications to provide exchange of global information and execution of global programs.
5. Operator interface software shall include day-to-day operator transaction processing, alarm and report handling, operator privilege level and data segregation control, custom programming, and online data modification capability.
6. Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.

B. Operator Interface Software:

1. Minimize operator training through use of English language pronouncing and English language point identification.
2. Minimize use of a typewriter-style keyboard through use of a pointing device similar to a mouse.
3. Operator sign-off shall be a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
4. Automatic sign-off period shall be programmable from one to 60 minutes in one-minute increments on a per operator basis.
5. Operator sign-on and sign-off activity shall be recorded and sent to printer.
6. Security Access:
  - a. Operator access to DDC system shall be under password control.
  - b. An alphanumeric password shall be field assignable to each operator.
  - c. Operators shall be able to access DDC system by entry of proper password.
  - d. Operator password shall be same regardless of which computer or other interface means is used.



- e. Additions or changes made to passwords shall be updated automatically.
  - f. Each operator shall be assigned an access level to restrict access to data and functions the operator is cable of performing.
  - g. Software shall have at least five access levels.
  - h. Each menu item shall be assigned an access level so that a one-for-one correspondence between operator assigned access level(s) and menu item access level(s) is required to gain access to menu item.
  - i. Display menu items to operator with those capable of access highlighted. Menu and operator access level assignments shall be online programmable and under password control.
7. Operators shall be able to perform commands including, but not limited to, the following:
- a. Start or stop selected equipment.
  - b. Adjust set points.
  - c. Add, modify, and delete time programming.
  - d. Enable and disable process execution.
  - e. Lock and unlock alarm reporting for each point.
  - f. Enable and disable totalization for each point.
  - g. Enable and disable trending for each point.
  - h. Override control loop set points.
  - i. Enter temporary override schedules.
  - j. Define holiday schedules.
  - k. Change time and date.
  - l. Enter and modify analog alarm limits.
  - m. Enter and modify analog warning limits.
  - n. View limits.
  - o. Enable and disable demand limiting.
  - p. Enable and disable duty cycle.
  - q. Display logic programming for each control sequence.
8. Reporting:
- a. Generated automatically and manually.
  - b. Sent to displays, printers, and disk files.
  - c. Types of Reporting:
    - 1) General listing of points.
    - 2) List points currently in alarm.
    - 3) List of off-line points.
    - 4) List points currently in override status.
    - 5) List of disabled points.
    - 6) List points currently locked out.
    - 7) List of items defined in a "Follow-Up" file.
    - 8) List weekly schedules.
    - 9) List holiday programming.
    - 10) List of limits and deadbands.
9. Summaries: For specific points, for a logical point group, for an operator selected group(s), or for entire system without restriction due to hardware configuration.

C. Graphic Interface Software:

- 1. Include a full interactive graphical selection means of accessing and displaying system data to operator. Include at least five levels with the penetration path operator assignable (for example, site, building, floor, air-handling unit, and supply temperature loop). Native

- language descriptors assigned to menu items are to be operator defined and modifiable under password control.
2. Include a hierarchical-linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation. Interface shall use a pointing device with pull-down or penetrating menus, color and animation to facilitate operator understanding of system.
  3. Include at least 10 levels of graphic penetration with the hierarchy operator assignable.
  4. Descriptors for graphics, points, alarms and such shall be modified through operator's workstation under password control.
  5. Graphic displays shall be online user definable and modifiable using the hardware and software provided.
  6. Data to be displayed within a graphic shall be assignable regardless of physical hardware address, communication or point type.
  7. Graphics are to be online programmable and under password control.
  8. Points may be assignable to multiple graphics where necessary to facilitate operator understanding of system operation.
  9. Graphics shall also contain software points.
  10. Penetration within a graphic hierarchy shall display each graphic name as graphics are selected to facilitate operator understanding.
  11. Back-trace feature shall permit operator to move upward in the hierarchy using a pointing device. Back trace shall show all previous penetration levels. Include operator with option of showing each graphic full screen size with back trace as horizontal header or by showing a "stack" of graphics, each with a back trace.
  12. Display operator accessed data on the monitor.
  13. Operator shall select further penetration using pointing device to click on a site, building, floor, area, equipment, and so on. Defined and linked graphic below that selection shall then be displayed.
  14. Include operator with means to directly access graphics without going through penetration path.
  15. Dynamic data shall be assignable to graphics.
  16. Display points (physical and software) with dynamic data provided by DDC system with appropriate text descriptors, status or value, and engineering unit.
  17. Use color, rotation, or other highly visible means, to denote status and alarm states. Color shall be variable for each class of points, as chosen by operator.
  18. For operators with appropriate privilege, points shall be commanded directly from display using pointing device.
    - a. For an analog command point such as set point, current conditions and limits shall be displayed and operator can position new set point using pointing device.
    - b. Keyboard equivalent shall be available for those operators with that preference.
  19. Operator shall be able to split or resize viewing screen into quadrants to show one graphic on one quadrant of screen and other graphics or spreadsheet, bar chart, word processing, curve plot and other information on other quadrants on screen. This feature shall allow real-time monitoring of one part of system while displaying other parts of system or data to better facilitate overall system operation.
  20. Help Features:
    - a. On-line context-sensitive help utility to facilitate operator training and understanding.
    - b. Bridge to further explanation of selected keywords. Document shall contain text and graphics to clarify system operation.
      - 1) If help feature does not have ability to bridge on keywords for more information, a complete set of user manuals shall be provided in an indexed

word-processing program, which shall run concurrently with operating system software.

c. Available for Every Menu Item:

1) Index items for each system menu item.

21. Graphic generation software shall allow operator to add, modify, or delete system graphic displays.

a. Include libraries of symbols depicting HVAC symbols such as fans, coils, filters, dampers and electrical symbols.

b. Graphic development package shall use a pointing device in conjunction with a drawing program to allow operator to perform the following:

1) Define background screens.

2) Define connecting lines and curves.

3) Locate, orient and size descriptive text.

4) Define and display colors for all elements.

5) Establish correlation between symbols or text and associated system points or other displays.

D. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:

1. Site plan showing each building, and additional site elements, which are being controlled or monitored by DDC system.

2. Plan for each building floor, including interstitial floors, and each roof level of each building, showing the following:

a. Room layouts with room identification and name.

b. Locations and identification of all monitored and controlled HVAC equipment and other equipment being monitored and controlled by DDC system.

c. Location and identification of each hardware point being controlled or monitored by DDC system.

3. Control schematic for each of following, including a graphic system schematic representation with point identification, set point and dynamic value indication and control logic diagram.

4. Graphic display for each piece of equipment connected to DDC system through a data communications link. Include dynamic indication of all points associated with equipment.

5. DDC system network riser diagram that shows schematic layout for entire system including all networks and all controllers, gateways, and operator workstation.

E. Customizing Software:

1. Software to modify and tailor DDC system to specific and unique requirements of equipment installed, to programs implemented and to staffing and operational practices planned.

2. Online modification of DDC system configuration, program parameters, and database using menu selection and keyboard entry of data into preformatted display templates.

3. As a minimum, include the following modification capability:

a. Operator assignment shall include designation of operator passwords, access levels, point segregation and auto sign-off.

- b. Peripheral assignment capability shall include assignment of segregation groups and operators to consoles and printers, designation of backup workstations and printers, designation of workstation header points and enabling and disabling of print-out of operator changes.
- c. System configuration and diagnostic capability shall include communications and peripheral port assignments, DDC controller assignments to network, DDC controller enable and disable, assignment of command trace to points and application programs and initiation of diagnostics.
- d. System text addition and change capability shall include English or native language descriptors for points, segregation groups and access levels and action messages for alarms, run time and trouble condition.
- e. Time and schedule change capability shall include time and date set, time and occupancy schedules, exception and holiday schedules and daylight savings time schedules.
- f. Point related change capability shall include the following:
  - 1) System and point enable and disable.
  - 2) Run-time enable and disable.
  - 3) Assignment of points to segregation groups, calibration tables, lockout, and run time and to a fixed I/O value.
  - 4) Assignment of alarm and warning limits.
- g. Application program change capability shall include the following:
  - 1) Enable and disable of software programs.
  - 2) Programming changes.
  - 3) Assignment of comfort limits, global points, time and event initiators, time and event schedules and enable and disable time and event programs.

Software shall allow operator to add points, or groups of points, to DDC system and to link them to energy optimization and management programs. Additions and modifications shall be online programmable using operator workstation, downloaded to other network devices, and entered into their databases. After verification of point additions and associated program operation, database shall be uploaded and recorded on hard drive and disk for archived record.

- 4. Include high-level language programming software capability for implementation of custom DDC programs. Software shall include a compiler, linker, and up- and down-load capability.
- 5. Include a library of DDC algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences. Also include, as a minimum, the following:
  - a. Proportional control (P).
  - b. Proportional plus integral (PI).
  - c. Proportional plus integral plus derivative (PID).
  - d. Adaptive and intelligent self-learning control.
    - 1) Algorithm shall monitor loop response to output corrections and adjust loop response characteristics according to time constant changes imposed.
    - 2) Algorithm shall operate in a continuous self-learning manner and shall retain in memory a stored record of system dynamics so that on system shut down and restart, learning process starts from where it left off.
- 6. Fully implemented intrinsic control operators including sequence, reversing, ratio, time delay, time of day, highest select AO, lowest select AO, analog controlled digital output, analog control AO, and digitally controlled AO.

7. Logic operators such as "And" "Or" "Not," and others that are part of a standard set available with a high-level language.
8. Arithmetic operators such as "Add," "Subtract," "Multiply," "Divide," and others that are part of a standard set available with a high-level language.
9. Relational operators such as "Equal To," "Not Equal To," "Less Than" "Greater Than" and others that are part of a standard set available with a high-level language.

F. Alarm Handling Software:

1. Include alarm handling software to report all alarm conditions monitored and transmitted through DDC controllers, gateways, and other network devices.
2. Include first in, first out handling of alarms according to alarm priority ranking, with most critical alarms first, and with buffer storage in case of simultaneous and multiple alarms.
3. Alarm handling shall be active at all times to ensure that alarms are processed even if an operator is not currently signed on to DDC system.
4. Alarms display shall include the following:
  - a. Indication of alarm condition such as "Abnormal Off," "Hi Alarm," and "Low Alarm."
  - b. "Analog Value" or "Status" group and point identification with native language point descriptor such as "Space Temperature, building 110, 2nd Floor, Room 212."
  - c. Discrete per point alarm action message, such as "Call Maintenance Dept. Ext-5561."
  - d. Include extended message capability to allow assignment and printing of extended action messages. Capability shall be operator programmable and assignable on a per point basis.
5. Alarms shall be directed to appropriate operator workstation, printer, and individual operators by privilege level and segregation assignments.
6. Send e-mail alarm messages to designated operators.
7. Send e-mail, page, text and voice messages to designated operators for critical alarms.
8. Alarms shall be categorized and processed by class.
  - a. Class 1:
    - 1) Associated with fire, security and other extremely critical equipment monitoring functions; have alarm, trouble, return to normal, and acknowledge conditions printed and displayed.
    - 2) Unacknowledged alarms to be placed in unacknowledged alarm buffer.
    - 3) All conditions shall cause an audible sound and shall require individual acknowledgment to silence audible sound.
  - b. Class 2:
    - 1) Critical, but not life-safety related, and processed same as Class 1 alarms, except do not require individual acknowledgment.
    - 2) Acknowledgement may be through a multiple alarm acknowledgment.
  - c. Class 3:
    - 1) General alarms; printed, displayed and placed in unacknowledged alarm buffer queues.
    - 2) Each new alarm received shall cause an audible sound. Audible sound shall be silenced by "acknowledging" alarm or by pressing a "silence" key.
    - 3) Acknowledgement of queued alarms shall be either on an individual basis or through a multiple alarm acknowledgement.

- 4) Alarms returning to normal condition shall be printed and not cause an audible sound or require acknowledgment.
- d. Class 4:
- 1) Routine maintenance or other types of warning alarms.
  - 2) Alarms to be printed only, with no display, no audible sound and no acknowledgment required.
9. Include an unacknowledged alarm indicator on display to alert operator that there are unacknowledged alarms in system. Operator shall be able to acknowledge alarms on an individual basis or through a multiple alarm acknowledge key, depending on alarm class.
  10. To ensure that no alarm records are lost, it shall be possible to assign a backup printer to accept alarms in case of failure of primary printer.
- G. Reports and Logs:
1. Include reporting software package that allows operator to select, modify, or create reports using DDC system I/O point data available.
  2. Each report shall be definable as to data content, format, interval and date.
  3. Report data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on workstation for historical reporting.
  4. Operator shall be able to obtain real-time logs of all I/O points by type or status, such as alarm, point lockout, or normal.
  5. Reports and logs shall be stored on workstation hard drives in a format that is readily accessible by other standard software applications, including spreadsheets and word processing.
  6. Reports and logs shall be readily printed and set to be printed either on operator command or at a specific time each day.
- H. Standard Reports: Standard DDC system reports shall be provided, and operator shall be able to customize reports later.
1. All I/O: With current status and values.
  2. Alarm: All current alarms, except those in alarm lockout.
  3. Disabled I/O: All I/O points that are disabled.
  4. Alarm Lockout I/O: All I/O points in alarm lockout, whether manual or automatic.
  5. Alarm Lockout I/O in Alarm: All I/O in alarm lockout that are currently in alarm.
  6. Logs:
    - a. Alarm history.
    - b. System messages.
    - c. System events.
    - d. Trends.
- I. Custom Reports: Operator shall be able to easily define any system data into a daily, weekly, monthly, or annual report. Reports shall be time and date stamped and shall contain a report title.
- J. Tenant Override Reports: Prepare Project-specific reports.
1. Weekly report showing daily total time in hours that each tenant has requested after-hours HVAC.
  2. Monthly report showing daily total time in hours that each tenant has requested after-hours HVAC.

3. Annual summary report that shows after-hours HVAC usage on a monthly basis.
- K. HVAC Equipment Reports: Prepare Project-specific reports.
- L. Energy Reports: Prepare Project-specific daily, weekly, monthly, and annual energy reports.
1. Prepare report for each energy utility, indicating the following:
    - a. Time period being reported with beginning and end date, and time indicated.
    - b. Consumption in units of measure commonly used to report specific utility consumption over time.
    - c. Cost per utility unit.
    - d. Utility cost per unit area.
    - e. Convert all utilities to a common energy consumption unit of measure and report for each utility.
    - f. Consumption per unit area using common unit of measure.
- M. Standard Trends:
1. Trend all I/O point present values, set points, and other parameters indicated for trending. The systems controlled and/or monitored shall include, but are not limited to the following:
    - a. Heating and Cooling Systems
    - b. Domestic Hot Water
    - c. Stairwell and Elevator Shaft Pressurization Systems
  2. Trends shall be associated into groups, and a trend report shall be set up for each group.
  3. Trends shall be stored within DDC controller and uploaded to hard drives automatically.
  4. Preset trend intervals for each I/O point after review with Owner.
  5. Trend intervals shall be operator selectable from 10 seconds up to 60 minutes. Minimum number of consecutive trend values stored at one time shall be 100 per variable.
  6. When drive storage memory is full, most recent data shall overwrite oldest data.
  7. Archived and real-time trend data shall be available for viewing numerically and graphically by operators.
- N. Custom Trends: Operator shall be able to define a custom trend log for any I/O point in DDC system.
1. Each trend shall include interval, start time, and stop time.
  2. Data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on workstation hard drives.
  3. Data shall be retrievable for use in spreadsheets and standard database programs.
- O. Programming Software:
1. Include programming software to execute sequences of operation indicated.
  2. Include programming routines in simple and easy to follow logic with detailed text comments describing what the logic does and how it corresponds to sequence of operation.
  3. Programing software shall be as follows:
    - a. Graphic Based: Programming shall use a library of function blocks made from preprogrammed code designed for DDC control systems.

- 1) Function blocks shall be assembled with interconnection lines that represent to control sequence in a flowchart.
  - 2) Programming tools shall be viewable in real time to show present values and logical results of each function block.
- b. Menu Based: Programming shall be done by entering parameters, definitions, conditions, requirements, and constraints.
4. Include means for detecting programming errors and testing software control strategies with a simulation tool before implementing in actual control. Simulation tool may be inherent with programming software or as a separate product.

P. Database Management Software:

1. Where a separate SQL database is used for information storage, DDC system shall include database management software that separates database monitoring and managing functions by supporting multiple separate windows.
2. Database secure access shall be accomplished using standard SQL authentication including ability to access data for use outside of DDC system applications.
3. Database management function shall include summarized information on trend, alarm, event, and audit for the following database management actions:
  - a. Backup.
  - b. Purge.
  - c. Restore.
4. Database management software shall support the following:
  - a. Statistics: Display database server information and trend, alarm, event, and audit information on database.
  - b. Maintenance: Include method of purging records from trend, alarm, event and audit databases by supporting separate screens for creating a backup before purging, selecting database, and allowing for retention of a selected number of day's data.
  - c. Backup: Include means to create a database backup file and select a storage location.
  - d. Restore: Include a restricted means of restoring a database by requiring operator to have proper security level.
5. Database management software shall include information of current database activity, including the following:
  - a. Ready.
  - b. Purging record from a database.
  - c. Action failed.
  - d. Refreshing statistics.
  - e. Restoring database.
  - f. Shrinking a database.
  - g. Backing up a database.
  - h. Resetting Internet information services.
  - i. Starting network device manager.
  - j. Shutting down the network device manager.
  - k. Action successful.



6. Database management software monitoring functions shall continuously read database information once operator has logged on.
7. Include operator notification through on-screen pop-up display and e-mail message when database value has exceeded a warning or alarm limit.
8. Monitoring settings window shall have the following sections:
  - a. Allow operator to set and review scan intervals and start times.
  - b. E-mail: Allow operator to create and review e-mail and phone text messages to be delivered when a warning or an alarm is generated.
  - c. Warning: Allow operator to define warning limit parameters, set reminder frequency and link e-mail message.
  - d. Alarm: Allow operator to define alarm limit parameters, set reminder frequency and link e-mail message.
  - e. Database Login: Protect system from unauthorized database manipulation by creating a read access and a write access for each of trend, alarm, event, and audit databases as well as operator proper security access to restore a database.
9. Monitoring settings taskbar shall include the following informational icons:
  - a. Normal: Indicates by color and size, or other easily identifiable means that all databases are within their limits.
  - b. Warning: Indicates by color and size, or other easily identifiable means that one or more databases have exceeded their warning limit.
  - c. Alarm: Indicates by color and size, or other easily identifiable means that one or more databases have exceeded their alarm limit.

Q. Real-Time Control Dashboard:

1. Provide in chart form a display indicating all mechanical system equipment and components.
2. The data listed for each system component should include that which is listed under "display and trending" in the "Sequence of Operations for HVAC Controls and Building Interface" section.
3. This display shall be in Real-Time and indicate all systems components simultaneously.
4. Separate page of all abbreviations used on the dashboard screens shall be created and available for review.
5. The points available in the charts of the dashboard shall correspond with the points displayed on the graphic screens. The same abbreviation and/or symbol shall be used for the same variable on the dashboard and on the graphic screens.
6. All data displayed on the dashboard shall be able to be saved and printed in the Excel spreadsheet format.
7. The sample of a dashboard is included below. The exact format and content of the dashboard shall be coordinated with the Client/User.
8. Provide current weather data and system optimization and anticipation based on historical weather data.

# SAMPLE ONLY

## Ambient Conditions

temp 63.6 °F  
RH 62 %

## MAJOR SYSTEMS - DASHBOARD MONITOR - Continued

### Air Distribution Systems

AHU-1		AHU-2		RTU-1		RTU-2	
Run Command	On	Run Command	On	Run Command	On	Run Command	On
Alarm	On	Alarm	On	Alarm 1	On	Alarm 1	On
SA Flow	8,530 CFM	SA Flow	6,450 CFM	SA Flow	12,200 CFM	SA Flow	9,630 CFM
OA Flow	1,830 CFM	OA Flow	1,380 CFM	OA Flow	2,500 CFM	OA Flow	2,010 CFM
SA Temp	55.2 °F	SA Temp	55.2 °F	SA Temp	60.1 °F	SA Temp	55.8 °F
SA Stpt	55.0 °F	SA Stpt	55.0 °F	SA Stpt	63.0 °F	SA Stpt	55.0 °F
CHW Valve	52 %	CHW Valve	25 %	SA Stpt	63.0 °F	SA Stpt	55.0 °F
HW Valve	0 %	HW Valve	0 %	SA RH	85.0 %	SA RH	83.0 %
SA Static Press	2.3 "wc	SA Static Press	1.5 "wc	DX Capacity	18 %	DX Capacity	75 %
SA Static Pres Stpt	2.3 "wc	SA Static Pres Stpt	1.5 "wc	HW Valve	0 %	HW Valve	0 %
VFD Speed	50 %	VFD Speed	56 %	SA Static Press	1.5 "wc	SA Static Press	1.5 "wc
Humidity Stpt	40 % rh	Humidity Stpt	35 % rh	SA Static Pres Stpt	1.5 "wc	SA Static Pres Stpt	1.5 "wc
Humidity	50.8 % rh	Humidity	57.4 % rh	VFD Speed	45.6 Hz	VFD Speed	52.8 Hz
Humidifier Cmd	0 %	Humidifier Cmd	0 %	Filter P.D.	0.75 in.WG	Filter P.D.	0.75 in.WG
Filter P.D.	0.75 in.WG	Filter P.D.	0.75 in.WG				

### Exhaust Systems

EF-1		EF-2	
Alarm	Off	Alarm	Off
S/S	On	S/S	On
Status	On	Status	On
Damper Status	Open	Damper Status	Open
EA Static Pres	-0.92 "wc	EA Static Pres	0.92 "wc
EA Static Pres Stpt	-1.00 "wc	EA Static Pres Stpt	-1.00 "wc

# SAMPLE ONLY

## INDIVIDUAL SYSTEMS - DASHBOARD MONITOR

HW System Supply Temp		167.1 °F		CHW System Supply Temp		47.5 °F		RTU-3														
Run	General	General	SA Flow	OA Flow	SA	SA	Temp Sipt	RH	SA	DX	HW	HW Coil	SA	SA	Static Press	Static Press	Sipt	Speed	VFD	Heat	Cool	
Command	Alarm1	Alarm2	CFM	CFM	Temp	Temp Sipt	°F	%	°F	Capacity	Valve	Lvg Temp	Static Press	Static Press	Sipt	Speed	49.2 Hz	2	21	Requests	Requests	
On	On	On	13,100	2,820	57.9	55.0 °F	83%	55.0%	0%	127.0 °F	1.5 "wc	1.5 "wc	1.5 "wc	1.5 "wc	49.2 Hz	2	21	2	21	2	21	
Area	Unit ID	Zone	Temp °F	Cig SP °F	Htg SP °F	Damp Pos	SA Temp °F	Airflow CFM	Airflow SP CFM	HW Valve	SA	Static Press	Static Press	Sipt	Speed	VFD	Heat	Cool	Requests	Requests		
361	vav 2-1	72.0	70.0	67.0	24.1%	56.6	244	250	0%													
368	vav 2-2	67.5	78.0	65.0	27.8%	55.7	88	85	0%													
321	vav 2-3	74.0	75.8	69.8	36.8%	57.1	88	80	0%													
315	vav 2-4	67.9	84.0	66.0	33.8%	56.5	125	115	0%													
325-328	vav 2-5	73.1	75.0	68.0	28.1%	57.0	162	150	0%													
340-343	vav 2-6	74.8	80.0	75.0	30.7%	80.0	174	170	14%													
344-347	vav 2-7	72.1	76.0	66.0	43.7%	56.9	183	170	0%													
348-352	vav 2-8	71.5	78.0	66.0	43.8%	56.5	306	280	0%													
370	vav 2-9	71.7	75.7	69.7	28.9%	56.6	359	350	0%													
363,366,380	vav 2-10	72.3	73.0	68.0	37.0%	56.5	87	80	0%													
381-383	vav 2-11	72.0	75.0	65.0	43.1%	55.6	122	115	0%													
386,387	vav 2-12	71.5	71.7	68.7	29.6%	55.2	278	265	0%													
377,378	vav 2-13	71.4	68.0	63.0	74.9%	55.7	549	550	0%													
312	vav 2-14	68.4	70.0	67.0	46.0%	57.6	87	85	0%													
358A	vav 2-15	68.0	70.0	67.0	31.3%	56.7	93	85	0%													
367	vav 2-16	68.0	70.0	67.0	36.3%	56.2	94	85	0%													
322	ftu 2-1	73.5	76.9	65.9	35.2%	69.0	109	100	0%													
323	ftu 2-2	71.3	70.0	65.0	55.2%	62.5	400	400	0%												661	
320	ftu 2-3	68.1	87.0	69.0	29.2%	81.5	551	525	100%													528
319	ftu 2-4	71.0	68.0	63.0	73.5%	57.5	1,800	1,800	0%													
332,333	ftu 2-5	71.7	68.0	63.0	85.9%	56.5	1,192	1,200	0%													

**SAMPLE ONLY**

**INDIVIDUAL SYSTEMS - DASHBOARD MONITOR - Continued**

HW System Supply Temp		167.1 °F										
CHW System Supply Temp		47.5 °F										
Run	General	SA Flow	OA Flow	SA	SA	DX	HW	HW Coil	SA	SA	VFD	Cool
Command	Alarm1	CFM	CFM	Temp	Temp Stp	Capacity	Valve	Lvg Temp	Static Press	Static Press Stp	Speed	Heat
On	On	13,100	2,820	57.9	55.0 °F	55.0%	0%	127.0 °F	1.5 "wc	1.5 "wc	49.2 Hz	2
	Alarm2	On	On	Temp	Temp Stp	RH	Valve	Valve	Static Press	Static Press Stp	Requests	Requests
	On	On	On	57.9	55.0 °F	83%	0%	127.0 °F	1.5 "wc	1.5 "wc	2	21

**RTU-3**

Area	Unit ID	Zone	Temp °F		Htg SP	Damp	SA Temp	Airflow		HW	CO2
			°F	Pos				CFM	SP CFM		
334,335	ftu 2-6	71.4	72.0	62.0	39.7%	56.2	220	220	0%	Off	
336	ftu 2-7	75.5	70.0	65.0	47.3%	57.2	400	400	0%	Off	
354	ftu 2-8	70.1	70.0	68.0	98.8%	67.4	1,088	1,100	0%	On	516
357	ftu 2-9	73.0	73.4	63.4	32.0%	64.4	351	360	0%	On	512
369	ftu 2-10	70.7	75.0	65.0	38.0%	64.4	148	145	0%	On	506
371,372	ftu 2-11	72.5	70.5	65.5	57.7%	64.4	1,198	1,200	0%	Off	
306	ftu 2-12	70.5	79.0	64.0	39.6%	64.4	79	75	0%	On	503
305	ftu 2-13	71.9	72.0	63.0	28.3%	64.4	162	163	0%	On	536
373,374	ftu 2-14	73.3	70.0	65.0	88.9%	64.4	1,005	1,000	0%	Off	
375,376	ftu 2-15	72.3	68.0	63.0	100.0%	64.4	1,099	1,200	0%	Off	
370	ftu 2-16	72.8	75.0	72.0	26.5%	64.4	152	145	0%	Off	

- A. Include BACnet communication ports, whenever available as an equipment OEM standard option, for integration via a single communication cable. BACnet-controlled plant equipment includes, but is not limited to, boilers, air handling units and variable-speed drives.
- B. Include gateways to connect BACnet to non-BACnet devices only when specifically requested and approved by Owner.
- C. Include with each gateway an interoperability schedule showing each point or event on legacy side that BACnet "client" will read, and each parameter that BACnet network will write to. Describe this interoperability of BACnet services, or BIBBs, defined in ASHRAE 135, Annex K.
- D. Gateway Minimum Requirements:
  - 1. Read and view all readable object properties on non-BACnet network to BACnet network and vice versa where applicable.
  - 2. Write to all writeable object properties on non-BACnet network from BACnet network and vice versa where applicable.
  - 3. Include single-pass (only one protocol to BACnet without intermediary protocols) translation from non-BACnet protocol to BACnet and vice versa.
  - 4. Comply with requirements of Data Sharing Read Property, Data Sharing Write Property, Device Management Dynamic Device Binding-B, and Device Management Communication Control BIBBs according to ASHRAE 135.
  - 5. Hardware, software, software licenses, and configuration tools for operator-to-gateway communications.
  - 6. Backup programming and parameters on CD media and the ability to modify, download, backup, and restore gateway configuration.

#### 2.14 DDC CONTROLLERS

- A. DDC system shall consist of a combination of network controllers, programmable application controllers and application-specific controllers to satisfy performance requirements indicated.
- B. DDC controllers shall perform monitoring, control, energy optimization and other requirements indicated.
- C. DDC controllers shall use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence.
- D. Each DDC controller shall be capable of full and complete operation as a completely independent unit and as a part of a DDC system wide distributed network.
- E. Environment Requirements:
  - 1. Controller hardware shall be suitable for the anticipated ambient conditions.
- F. Maintenance and Support: Include the following features to facilitate maintenance and support:
  - 1. Mount microprocessor components on circuit cards for ease of removal and replacement.
  - 2. Means to quickly and easily disconnect controller from network.
  - 3. Means to quickly and easily access connect to field test equipment.
  - 4. Visual indication that controller electric power is on, of communication fault or trouble, and that controller is receiving and sending signals to network.

G. Input and Output Point Interface:

1. Hardwired input and output points shall connect to network, programmable application and application-specific controllers.
2. Input and output points shall be protected so shorting of point to itself, to another point, or to ground will not damage controller.
3. Input and output points shall be protected from voltage up to 24 V of any duration so that contact will not damage controller.

2.15 NETWORK CONTROLLERS

A. General Network Controller Requirements:

1. Include adequate number of controllers to achieve performance indicated.
2. System shall consist of one or more independent, standalone, microprocessor-based network controllers to manage global strategies indicated.
3. Controller shall have enough memory to support its operating system, database, and programming requirements.
4. Data shall be shared between networked controllers and other network devices.
5. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
6. Controllers that perform scheduling shall have a real-time clock.
7. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
8. Controllers shall be fully programmable.

B. Communication:

1. Network controllers shall communicate with other devices on DDC system network.
2. Network controller also shall perform routing if connected to a network of programmable application and application-specific controllers.

C. Operator Interface:

1. Controller shall be equipped with a service communications port for connection to a portable operator's workstation.

D. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall maintain BIOS and programming information in event of a power loss for at least 72 hours.

2.16 PROGRAMMABLE APPLICATION CONTROLLERS

A. General Programmable Application Controller Requirements:

1. Include adequate number of controllers to achieve performance indicated.
2. Controller shall have enough memory to support its operating system, database, and programming requirements.

3. Data shall be shared between networked controllers and other network devices.
4. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
5. Controllers that perform scheduling shall have a real-time clock.
6. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
7. Controllers shall be fully programmable.

B. Communication:

1. Programmable application controllers shall communicate with other devices on network.

C. Operator Interface:

1. Controller shall be equipped with a service communications port for connection to a portable operator's workstation.

D. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall maintain BIOS and programming information in event of a power loss for at least 72 hours.

## 2.17 APPLICATION-SPECIFIC CONTROLLERS

A. Description: Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. Controllers are not fully user-programmable but are configurable and customizable for operation of equipment they are designed to control.

1. Capable of standalone operation and shall continue to include control functions without being connected to network.
2. Data shall be shared between networked controllers and other network devices.

B. Communication: Application-specific controllers shall communicate with other application-specific controller and devices on network, and to programmable application and network controllers.

C. Operator Interface: Controller shall be equipped with a service communications port for connection to a portable operator's workstation.

D. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall use nonvolatile memory and maintain all BIOS and programming information in event of power loss.

## 2.18 CONTROLLER SOFTWARE

### A. General Controller Software Requirements:

1. Software applications shall reside and operate in controllers. Editing of applications shall occur at operator workstations.
2. Control functions shall be executed within controllers using DDC algorithms.
3. Controllers shall be configured to use stored default values to ensure fail-safe operation. Default values shall be used when there is a failure of a connected input instrument or loss of communication of a global point value.

### B. Security:

1. Operator access shall be secured using individual security passwords and user names.
2. Passwords shall restrict operator to points, applications, and system functions as assigned by system manager.
3. Operator log-on and log-off attempts shall be recorded.
4. System shall protect itself from unauthorized use by automatically logging off after last keystroke. The delay time shall be operator-definable.

### C. Scheduling: Include capability to schedule each point or group of points in system. Each schedule shall consist of the following:

#### 1. Weekly Schedule:

- a. Include separate schedules for each day of week.
- b. Each schedule should include the capability for start, stop, optimal start, optimal stop, and night economizer.
- c. Each schedule may consist of up to 10 events.
- d. When a group of objects are scheduled together, include capability to adjust start and stop times for each member.

#### 2. Exception Schedules:

- a. Include ability for operator to designate any day of the year as an exception schedule.
- b. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by regular schedule for that day of week.

#### 3. Holiday Schedules:

- a. Include capability for operator to define up to 99 special or holiday schedules.
- b. Schedules may be placed on scheduling calendar and will be repeated each year.
- c. Operator shall be able to define length of each holiday period.

### D. System Coordination:

1. Include standard application for proper coordination of equipment.
2. Application shall include operator with a method of grouping together equipment based on function and location.
3. Group may then be used for scheduling and other applications.

### E. Alarm Reporting:



1. Operator shall be able to determine action to be taken in event of an alarm.
2. Alarms shall be routed to appropriate operator workstations based on time and other conditions.
3. Alarm shall be able to start programs, print, be logged in event log, generate custom messages, and display graphics.

F. Remote Communication:

1. System shall have ability to dial out in the event of an alarm.

G. Maintenance Management: System shall monitor equipment status and generate maintenance messages based on operator-designated run-time, starts, and calendar date limits.

H. Sequencing: Include application software based on sequences of operation indicated to properly sequence chillers, boilers, and other applicable HVAC equipment.

I. Control Loops:

1. Support any of the following control loops, as applicable to control required:

- a. Two-position (on/off, open/close, slow/fast) control.
- b. Proportional control.
- c. Proportional plus integral (PI) control.
- d. Proportional plus integral plus derivative (PID) control.

- 1) Include PID algorithms with direct or reverse action and anti-windup.
- 2) Algorithm shall calculate a time-varying analog value used to position an output or stage a series of outputs.
- 3) Controlled variable, set point, and PID gains shall be operator-selectable.

- e. Adaptive (automatic tuning).

J. Staggered Start: Application shall prevent all controlled equipment from simultaneously restarting after a power outage. Order which equipment (or groups of equipment) is started, along with the time delay between starts, shall be operator-selectable.

K. Energy Calculations:

1. Include software to allow instantaneous power or flow rates to be accumulated and converted to energy usage data.
2. Include an algorithm that calculates a sliding-window average (rolling average). Algorithm shall be flexible to allow window intervals to be operator specified (such as 15, 30, or 60 minutes).
3. Include an algorithm that calculates a fixed-window average. A digital input signal shall define start of window period (such as signal from utility meter) to synchronize fixed-window average with that used by utility.

L. Run-Time Totalization:

1. Include software to totalize run-times for applicable points.
2. A high run-time alarm shall be assigned, if required, by operator.

## 2.19 ELECTRICAL POWER DEVICES

A. DC Power Supply:

1. Plug-in style suitable for mating with a standard eight-pin octal socket. Include the power supply with a mating mounting socket.
2. Enclose circuitry in a housing.
3. Include both line and load regulation to ensure a stable output. To protect both the power supply and the load, power supply shall have an automatic current limiting circuit.
4. Performance:
  - a. Output voltage nominally 25-V dc within 5 percent.
  - b. Output current up to 100 mA.
  - c. Input voltage nominally 120-V ac, 60 Hz.
  - d. Load regulation within 0.5 percent from zero- to 100-mA load.
  - e. Line regulation within 0.5 percent at a 100-mA load for a 10 percent line change.
  - f. Stability within 0.1 percent of rated volts for 24 hours after a 20-minute warmup.

## 2.20 UNINTERRUPTABLE POWER SUPPLY (UPS) UNITS

- A. UPS units shall provide continuous, regulated output power without using their batteries during brown-out, surge, and spike conditions.
- B. Load served shall not exceed 75 percent of UPS rated capacity, including power factor of connected loads.
  1. Larger-capacity units shall be provided for systems with larger connected loads.
  2. UPS shall provide 15 minutes of battery power.
- C. Performance:
  1. Input Voltage: Single phase, 120- or 230-V ac, compatible with field power source.
  2. Load Power Factor Range (Crest Factor): 0.65 to 1.0.
  3. Output Voltage: 101- to 132-V ac, while input voltage varies between 89 and 152-V ac.
  4. On Battery Output Voltage: Sine wave.
  5. Inverter overload capacity shall be minimum 150 percent for 30 seconds.
  6. Recharge time shall be a maximum of six hours to 90 percent capacity after full discharge to cutoff.
  7. Transfer Time: 6 ms.
  8. Surge Voltage Withstand Capacity: IEEE C62.41, Categories A and B; 6 kV/200 and 500 A; 100-kHz ringwave.
- D. UPS shall be automatic during fault or overload conditions.
- E. Unit with integral line-interactive, power condition topology to eliminate all power contaminants.
- F. Include front panel with power switch and visual indication of power, battery, fault and temperature.
- G. Unit shall include an audible alarm of faults and front panel silence feature.
- H. Unit with four NEMA WD 1, NEMA WD 6 Configuration 5-15R receptacles.
- I. UPS shall include dry contacts (digital output points) for low battery condition and battery-on (primary utility power failure).
- J. Batteries shall be sealed lead-acid type and be maintenance free. Battery replacement shall be front accessible by user without dropping load.

- K. Include tower models installed in ventilated cabinets to the particular installation location.

## 2.21 ACCESSORIES

### A. Pressure Electric Switches:

1. Diaphragm-operated snap acting switch.
2. Set point adjustable from 3 to 20 psig.
3. Differential adjustable from 2 to 6 psig.
4. Rated for resistance loads at 120-V ac.
5. Body and switch housing shall be metal.

### B. Damper Blade Limit Switches:

1. Sense positive open and/or closed position of the damper blades.
2. NEMA 250, Type 13, oil-tight construction.
3. Arrange for the mounting application.
4. Additional waterproof enclosure when required by its environment.
5. Arrange to prevent "over-center" operation.

### C. Instrument Enclosures:

1. Include instrument enclosure for secondary protection to comply with requirements indicated in "Performance Requirements" Article.
2. NRTL listed and labeled to UL 50.
3. Sized to include at least 25 percent spare area on subpanel.
4. Instrument(s) mounted within enclosure on internal subpanel(s).
5. Enclosure face with engraved, laminated phenolic nameplate for each instrument within enclosure.
6. Enclosures housing multiple instruments shall route wiring within enclosure in a raceway having a continuous removable cover.
7. Enclosures larger than 12 inches shall have a hinged full-size face cover.
8. Equip enclosure with lock and common key.

## 2.22 IDENTIFICATION

### A. Control Equipment, Instruments, and Control Devices:

1. Engraved tag bearing unique identification.
  - a. Include instruments with unique identification identified by equipment being controlled or monitored, followed by point identification.
2. Tag shall consist of white lettering on black background.
3. Tag shall be engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers are color-coded black with contrasting white center exposed by engraving through outer layer.
4. Tag shall be fastened with drive pins.
5. Instruments, control devices and actuators with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.

### B. Raceway and Boxes:

1. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
2. Paint cover plates on junction boxes and conduit same color as the tape banding for conduits. After painting, label cover plate "HVAC Controls," using an engraved phenolic tag.

C. Equipment Warning Labels:

1. Acrylic label with pressure-sensitive adhesive back and peel-off protective jacket.
2. Lettering size shall be at least 14-point type with white lettering on red background.
3. Warning label shall read "CAUTION-Equipment operated under remote automatic control and may start or stop at any time without warning. Switch electric power disconnecting means to OFF position before servicing."
4. Lettering shall be enclosed in a white line border. Edge of label shall extend at least 0.25 inch beyond white border.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
1. Verify compatibility with and suitability of substrates.
- B. Examine roughing-in for products to verify actual locations of connections before installation.
1. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
  2. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

A. Communication Interface to Equipment with Integral Controls:

1. DDC system shall have communication interface with equipment having integral controls and having a communication interface for remote monitoring or control.
2. Equipment to Be Connected:
  - a. Air handling units with packaged controls.
  - b. VRF systems with packaged controls.
  - c. VAV and fan powered boxes.
  - d. Unit heaters, cabinet unit heaters and wall heaters.
  - e. Stairwell and elevator shaft pressurization systems.
  - f. Ventilation fans and exhaust air fans.
  - g. Domestic water booster pumps.

- B. Communication Interface to Other Building Systems:
  - 1. DDC system shall have a communication interface with systems having a communication interface.
  - 2. Systems to Be Connected:
    - a. Fire-alarm system specified in Section 284611.11 " Addressable Fire Alarm System."
    - b. Domestic water and gas sub meters.

### 3.3 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

- A. Deliver selected control devices, specified in indicated HVAC instrumentation and control device Sections, to identified equipment and systems manufacturers for factory installation and to identified installers for field installation.
- B. Deliver all duct mounted devices to the duct fabricator and Installer for installation in ductwork. Include installation instructions to Installer and supervise installation for compliance with requirements.
- C. Deliver all pipe mounted devices to plumbing and HVAC piping installers for installation in piping. Include installation instructions to Installer and supervise installation for compliance with requirements.

### 3.4 GENERAL INSTALLATION REQUIREMENTS

- A. Install products to satisfy more stringent of all requirements indicated, including manufacturer's recommendations.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Support products, conduit, wiring and raceways. Brace products to prevent lateral movement and sway or a break in attachment.
- D. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.
- E. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- F. Firestop penetrations made in fire-rated assemblies.
- G. Seal penetrations made in acoustically rated assemblies.
- H. Fastening Hardware:
  - 1. Stillson wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
  - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
  - 3. Lubricate threads of bolts, nuts and screws with graphite and oil before assembly.

- I. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.
- J. If a field-mounted device or piece of equipment requires 120 V ac service and is mounted at a different location from 120 V ac power source provided under Electrical: Division 26, provide extensions to power wiring, including conduit, junction boxes, and other hardware, in accordance with Electrical: Division 26. This requirement shall also apply to devices powered by 24 V ac.
- K. Damper actuators that are placed in plenums shall be mounted on damper frames. Damper actuators shall not be installed in ducts or fresh-air intakes.
- L. Thermostats, temperature sensors, humidistats and humidity sensors located on exterior walls shall be mounted on back-insulated blocks.
- M. Provide labor for coordination and preparation during third party commissioning and testing/ balancing of systems as performed under Testing and Balancing of Mechanical Systems: Division 1 and Preparation for Testing and Balancing of Mechanical Systems: Division 23.
- N. Provide required cooperation and coordination with Electrical: Division 26 such that all power and ground wiring is provided in accordance with DDC system equipment manufacturer's written recommendations. DDC system supplier/installer shall make final electrical connections to DDC system equipment.
- J. Keep cable runs as short as possible, allowing extra length for connecting to terminal boards. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners or through penetrations. Provide strain relief loops in wiring harness between sub-panel terminal points and panel-mounted components.
- K. Temperature:
  - 1. RTDs: RTDs may be used in ducts, piping or spaces. When RTD is installed in pipes, it shall be installed in a thermowell. Coordinate thermowell locations with Mechanical Installer. When installed in airstreams or spaces, RTDs shall be rigidly supported. RTDs used for space-temperature sensing shall include a housing suitable for wall mounting. RTDs used for outside-air sensing shall have an instrument shelter to minimize solar effects, and shall be mounted to isolate building thermal effects. All RTD assemblies shall be readily accessible and installed in such a manner as to allow for easy replacement. Sensors located outdoors shall be NEMA 4 rated.
  - 2. Temperature Switches: Install temperature switches as specified for RTDs. Temperature switches shall be verified by calibration. Switch contact ratings shall be selected so as to meet expected load.
- L. Pressure:
  - 1. Pressure Switches: Pressure switches shall be adjusted to proper setpoint, and shall be verified by calibration. Pressure switches shall be mounted higher than process connection.
  - 2. Size (for specific range) and adjust each differential-pressure switch used for fan status to ensure reliable monitoring and eliminate false status feedback.
- M. Provide weathershield/enclosure to protect actuators and linkages from outside conditions of snow and ice build-up.

- N. Provide NEMA 4 enclosures for electric or electronic devices mounted in outdoor locations.
- O. Keep cable runs as short as possible, allowing extra length for connecting to terminal boards. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners or through penetrations. Provide strain relief loops in wiring harness between sub-panel terminal points and panel-mounted components.

### 3.5 OPERATOR WORKSTATION INSTALLATION

#### A. Desktop Operator Workstations Installation:

1. Install software on workstation and verify software functions properly.
2. Develop Project-specific graphics, trends, reports, logs and historical database.
3. Power workstation through a dedicated UPS unit. Locate UPS adjacent to workstation.

#### B. Color Graphics Application:

1. Use system schematics indicated as starting point to create graphics.
2. Develop Project-specific library of symbols for representing system equipment and products.
3. Incorporate digital images of Project-completed installation into graphics where beneficial to enhance effect.
4. Submit sketch of graphic layout with description of all text for each graphic for Owner's and Engineer's review before creating graphic using graphics software.
5. Seek Owner input in graphics development once using graphics software.
6. Final editing shall be done on-site with Owner's and Engineer's review and feedback.
7. Refine graphics as necessary for Owner acceptance.
8. On receiving Owner acceptance, print a hard copy for inclusion in operation and maintenance manual. Prepare a scanned copy PDF file of each graphic and include with softcopy of DDC system operation and maintenance manual.

### 3.6 GATEWAY INSTALLATION

- A. Install gateways if required for DDC system communication interface requirements indicated.
- B. Test gateways to verify that communication interfaces function properly.

### 3.7 CONTROLLER INSTALLATION

- A. Install controllers in enclosures to comply with indicated requirements.
- B. Connect controllers to field power supply.
- C. Install controller with latest version of applicable software and configure to execute requirements indicated.
- D. Test and adjust controllers to verify operation of connected I/O to achieve performance indicated requirements while executing sequences of operation.
- E. Installation of Network Controllers:
  1. Quantity and location of network controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
  2. Install controllers in a protected location that is easily accessible by operators.

- F. Installation of Programmable Application Controllers:
  - 1. Quantity and location of programmable application controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
  - 2. Install controllers in a protected location that is easily accessible by operators.
  
- G. Application-Specific Controllers:
  - 1. Quantity and location of application-specific controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
  - 2. For controllers not mounted directly on equipment being controlled, install controllers in a protected location that is easily accessible by operators.

### 3.8 ELECTRIC POWER CONNECTIONS

- A. Connect electrical power to DDC system products requiring electrical power connections.
- B. Design of electrical power to products not indicated with electric power is delegated to DDC system provider and installing trade. Work shall comply with NFPA 70 and other requirements indicated.
- C. Comply with requirements in Division 26 for electrical power circuit breakers.
- D. Comply with requirements in Division 26 for electrical power conductors and cables.
- E. Comply with requirements in Division 26 for electrical power raceways and boxes.

### 3.9 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements in Division 26 for identification products and installation.
- B. Install engraved phenolic nameplate with unique identification on face for each of the following:
  - 1. Gateway.
  - 2. DDC controller.
  - 3. Enclosure.
  - 4. Electrical power device.
  - 5. UPS unit.
- C. Install engraved phenolic nameplate with unique instrument identification on face of each instrument connected to a DDC controller.
- D. Where product is installed above accessible tile ceiling, also install matching engraved phenolic nameplate with identification on face of ceiling grid located directly below.
- E. Where product is installed above an inaccessible ceiling, also install engraved phenolic nameplate with identification on face of access door directly below.
- F. Warning Labels:
  - 1. Shall be permanently attached to equipment that can be automatically started by DDC control system.
  - 2. Shall be located in highly visible location near power service entry points.



### 3.10 NETWORK INSTALLATION

- A. Install copper cable or fiber-optic cable when connecting between network devices.

### 3.11 NETWORK NAMING AND NUMBERING

- A. Coordinate with Owner and provide unique naming and addressing for networks and devices.

### 3.12 CONTROL WIRE, CABLE, AND RACEWAYS INSTALLATION

- A. Wiring Method:

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways, boxes, and conduits specified in Division 26.

- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

- C. Field Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

- D. Conduit Installation:

1. Install conduit expansion joints where conduit runs exceed 200 feet, and conduit crosses building expansion joints.
2. Coordinate conduit routing with other trades to avoid conflicts with ducts, pipes and equipment and service clearance.
3. Maintain at least 3-inch separation where conduits run axially above or below ducts and pipes.
4. Limit above-grade conduit runs to 100 feet without pull or junction box.
5. Do not install raceways or electrical items on any "explosion-relief" walls, or rotating equipment.
6. Do not fasten conduits onto the bottom side of a metal deck roof.
7. Flexible conduit is permitted only where flexibility and vibration control is required.
8. Limit flexible conduit to 3 feet long.
9. Conduit shall be continuous from outlet to outlet, from outlet to enclosures, pull and junction boxes, and shall be secured to boxes in such manner that each system shall be electrically continuous throughout.
10. Direct bury conduits underground or install in concrete-encased duct bank where indicated.
  - a. Use rigid, nonmetallic, Schedule 80 PVC.
  - b. Provide a burial depth according to NFPA 70, but not less than 24 inches.
11. Secure threaded conduit entering an instrument enclosure, cabinet, box, and trough, with a locknut on outside and inside, such that conduit system is electrically continuous throughout. Provide a metal bushing on inside with insulated throats. Locknuts shall be the type designed to bite into the metal or, on inside of enclosure, shall have a grounding wedge lug under locknut.
12. Conduit box-type connectors for conduit entering enclosures shall have an insulated throat.
13. Connect conduit entering enclosures in wet locations with box-type connectors or with watertight sealing locknuts or other fittings.
14. Offset conduits where entering surface-mounted equipment.

15. Seal conduit runs used by sealing fittings to prevent the circulation of air for the following:
  - a. Conduit extending from interior to exterior of building.
  - b. Conduit extending into pressurized duct and equipment.
  - c. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.

E. Wire and Cable Installation:

1. Cables serving a common system may be grouped in a common raceway. Install control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
2. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.
  - a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.
3. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
5. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.
6. Provide strain relief.
7. Terminate wiring in a junction box.
  - a. Clamp cable over jacket in junction box.
  - b. Individual conductors in the stripped section of the cable shall be slack between the clamping point and terminal block.
8. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
9. Install signal transmission components according to IEEE C2, REA Form 511a, NFPA 70, and as indicated.
10. Keep runs short. Allow extra length for connecting to terminal boards. Do not bend flexible coaxial cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
11. Ground wire shall be copper and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.
12. Wire and cable shall be continuous from terminal to terminal without splices.
13. Use insulated spade lugs for wire and cable connection to screw terminals.
14. Use shielded cable to transmitters.
15. Use shielded cable to temperature sensors.
16. Perform continuity and meager testing on wire and cable after installation.
17. Do not install bruised, kinked, scored, deformed, or abraded wire and cable. Remove and discard wire and cable if damaged during installation and replace it with new cable.
18. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
19. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
20. Protection from Electro-Magnetic Interference (EMI): Provide installation free of (EMI). As a minimum, comply with the following requirements:

- a. Comply with BICSI TDMM and TIA 569-C for separating unshielded cable from potential EMI sources, including electrical power lines and equipment.
- b. Separation between open cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
  - 1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
  - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
  - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
- c. Separation between cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
  - 1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
  - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
  - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
- d. Separation between cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
  - 1) Electrical Equipment Rating Less Than 2 kVA: No requirement.
  - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
  - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
- e. Separation between Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.
- f. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

### 3.13 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the third-party commissioning agent:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Testing:
  - 1. Perform preinstallation, in-progress, and final tests, supplemented by additional tests, as necessary.
  - 2. Preinstallation Cable Verification: Verify integrity and serviceability for new cable lengths before installation. This assurance may be provided by using vendor verification documents, testing, or other methods. As a minimum, furnish evidence of verification for cable attenuation and bandwidth parameters.
  - 3. In-Progress Testing: Perform standard tests for correct pair identification and termination during installation to ensure proper installation and cable placement. Perform tests in addition to those specified if there is any reason to question condition of material furnished and installed. Testing accomplished is to be documented by agency conducting tests. Submit test results for Project record.
  - 4. Final Testing: Perform final test of installed system to demonstrate acceptability as installed. Testing shall be performed according to a test plan supplied by DDC system manufacturer.

Defective Work or material shall be corrected and retested. As a minimum, final testing for cable system, including spare cable, shall verify conformance of attenuation, length, and bandwidth parameters with performance indicated.

5. Test Equipment: Use a fiber-optic time domain reflectometer for testing of length and optical connectivity.
6. Test Results: Record test results and submit copy of test results for Project record.

### 3.14 DDC SYSTEM I/O CHECKOUT PROCEDURES

- A. Check installed products before continuity tests, leak tests and calibration.
- B. Check instruments for proper location and accessibility.
- C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
- D. Control Damper Checkout:
  1. Verify that control dampers are installed correctly for flow direction.
  2. Verify that proper blade alignment, either parallel or opposed, has been provided.
  3. Verify that damper frame attachment is properly secured and sealed.
  4. Verify that damper actuator and linkage attachment is secure.
  5. Verify that actuator wiring is complete, enclosed and connected to correct power source.
  6. Verify that damper blade travel is unobstructed.
- E. Instrument Checkout:
  1. Verify that instrument is correctly installed for location, orientation, direction and operating clearances.
  2. Verify that attachment is properly secured and sealed.
  3. Verify that conduit connections are properly secured and sealed.
  4. Verify that wiring is properly labeled with unique identification, correct type and size and is securely attached to proper terminals.
  5. Inspect instrument tag against approved submittal.
  6. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
  7. For temperature instruments:
    - a. Verify sensing element type and proper material.
    - b. Verify length and insertion.

### 3.15 DDC SYSTEM I/O ADJUSTMENT, CALIBRATION AND TESTING:

- A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
- B. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment for review by the third-party commissioning agent.
- C. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
- D. Equipment and procedures used for calibration shall comply with instrument manufacturer's written instructions.

- E. Provide diagnostic and test equipment for calibration and adjustment.
- F. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. An installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
- G. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
- H. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
- I. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.
- J. Analog Signals:
  - 1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
  - 2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
  - 3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.
- K. Digital Signals:
  - 1. Check digital signals using a jumper wire.
  - 2. Check digital signals using an ohmmeter to test for contact making or breaking.
- L. Control Dampers:
  - 1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
  - 2. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed and 100 percent open at proper air pressure.
  - 3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
  - 4. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.
- M. Meters: Check sensors at zero, 50, and 100 percent of Project design values.
- N. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.
- O. Switches: Calibrate switches to make or break contact at set points indicated.
- P. Transmitters:
  - 1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
  - 2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

### 3.16 DDC SYSTEM CONTROLLER CHECKOUT

- A. Verify power supply.
  - 1. Verify voltage, phase, and hertz.
  - 2. Verify that protection from power surges is installed and functioning.
  - 3. Verify that ground fault protection is installed.
  - 4. If applicable, verify if connected to UPS unit.
  - 5. If applicable, verify if connected to a backup power source.
  - 6. If applicable, verify that power conditioning units, transient voltage suppression and high-frequency noise filter units are installed.
- B. Verify that wire and cabling is properly secured to terminals and labeled with unique identification.
- C. Verify that spare I/O capacity is provided.

### 3.17 DDC CONTROLLER I/O CONTROL LOOP TESTS

- A. Testing:
  - 1. Test every I/O point connected to DDC controller to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
  - 2. Test every I/O point throughout its full operating range.
  - 3. Test every control loop to verify operation is stable and accurate.
  - 4. Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
  - 5. Test and adjust every control loop for proper operation according to sequence of operation.
  - 6. Test software and hardware interlocks for proper operation. Correct deficiencies.
  - 7. Operate each analog point at the following:
    - a. Upper quarter of range.
    - b. Lower quarter of range.
    - c. At midpoint of range.
  - 8. Exercise each binary point.
  - 9. For every I/O point in DDC system, read and record each value at operator workstation, at DDC controller and at field instrument simultaneously. Value displayed at operator workstation, at DDC controller and at field instrument shall match.
  - 10. Prepare and submit a report documenting results for each I/O point in DDC system and include in each I/O point a description of corrective measures and adjustments made to achieve desired results.

### 3.18 FINAL REVIEW

- A. Submit written request to Commissioning Agent and Construction Manager when DDC system is ready for final review. Written request shall state the following:
  - 1. DDC system has been thoroughly inspected for compliance with contract documents and found to be in full compliance.

2. DDC system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed and other performance requirements indicated.
  3. DDC system monitoring and control of HVAC systems results in operation according to sequences of operation indicated.
  4. DDC system is complete and ready for final review.
- B. Review by Commissioning Agent and Construction Manager shall be made after receipt of written request. A field report shall be issued to document observations and deficiencies.
  - C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.
  - D. Should more than two reviews be required, DDC system manufacturer and Installer shall compensate entity performing review for total costs, labor, and expenses, associated with third and subsequent reviews. Estimated cost of each review shall be submitted and approved by DDC system manufacturer and Installer before making the review.
  - E. Prepare and submit closeout submittals when no deficiencies are reported.
  - F. A part of DDC system final review shall include a demonstration to parties participating in final review.

### 3.19 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions.

### 3.20 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for one year.
- B. Provide ten software licenses with the system.
- C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within one year from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

### 3.21 DEMONSTRATION

- A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain DDC system.
  1. Provide not less than five days of on-site training total.
  2. Training shall be six, four-hour sessions, professionally video recorded.
  3. Stagger training over multiple training classes to accommodate Owner's requirements. All training shall occur before end of warranty period.

4. All training off-site at the factory/vendor's facility shall include the costs of travel, food and lodging for the owners staff. All travel and hotel accommodations shall be prior approved by the owner.

END OF SECTION



## SECTION 230993.11

### SEQUENCE OF OPERATIONS FOR HVAC DDC

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section includes control sequences for DDC for HVAC systems, subsystems, and equipment.
- B. Related Requirements:
  - 1. Section 230923 "DDC Systems for HVAC" for control equipment.

##### 1.4 DEFINITIONS

- A. Analog Output: Proportional output signal (zero- to 10-V dc, 4 to 20 mA).
- B. Binary Output: On/off output signal or contact closure.
- C. DDC: Direct digital control.
- D. Digital Output: Data output that must be interpreted digitally.

##### 1.5 ACTION SUBMITTALS

- A. Product Data:
  - 1. An instrumentation list for each controlled system. Label each element of the controlled system in table format. Show, in the table element name, type of device, manufacturer, model number, and control device product data sheet number.
  - 2. A complete description of the operation of the control system, including sequences of operation. Include and reference a schematic diagram of the controlled system.
- B. Shop Drawings:
  - 1. Riser diagrams showing control network layout, communication protocol, and wire types.
  - 2. Schematic diagram of each controlled system. Include all control points labeled with point names shown or listed. Show the location of control elements in the system.
  - 3. Wiring diagram for each controlled system. Show all control elements labels. Where a control element is the same as that shown on the control system schematic, label with the same name. Label all terminals.

## 1.6 AIR-HANDLING-UNIT CONTROL SEQUENCES

### A. Air-Handling Unit Time Schedule:

#### 1. Occupied Time Schedule:

##### a. Input:

- 1) Device: DDC controller.
- 2) Location: Time schedule.
- 3) Transference: DDC controller.

##### b. Output:

- 1) Device: DDC controller.

##### c. Action:

- 1) Enable startup, initiation, and control.
- 2) Energize unit on occupied/unoccupied cycle.
- 3) Energize unit on day/night cycle.
- 4) Energize unit on duty cycle.
- 5) Energize return-air fans 30 seconds after supply fans are energized.
- 6) Do not enable mixed-air control during morning warm-up period.
  - a) Unoccupied: Position outdoor-air and relief-air dampers closed and return-air dampers open.
- 7) Do not enable humidifier control during morning warm-up period.
- 8) Enable control of gas heating during morning warm-up period.
- 9) Do not enable cooling-coil control during morning warm-up period.

### B. Start and Stop Supply Fan(s):

#### 1. Enable:

##### a. Input:

- 1) Device: Smoke detector with auxiliary contact manual reset.
- 2) Location: Duct mounted before and after supply fan.
- 3) Location: Mounted in air-handling unit.
- 4) Transference: Starter relay.

##### b. Output:

- 1) Device: Hard wired.
- 2) Location: Motor controller.
- 3) Transference: Starter relay.

##### c. Output Device: Hard wired through motor controller; DDC controller alarm.

##### d. Action:

- 1) Allow start if airstream is free of products of combustion.
- 2) Signal alarm if fan fails to start as commanded.

C. Supply Fan(s) Variable-Volume Control:

1. Fan Speed Control:

a. Input:

- 1) Device: Air pressure transmitter.
- 2) Location: Supply-duct static pressure referenced to ambient-space static pressure.
- 3) Transference: DDC controller.

b. Output:

- 1) Device: Analog output.
- 2) Transference: Variable-frequency motor controller.

c. Action:

- 1) Maintain constant supply-duct static-pressure set point.
- 2) Set-Point Reset (for Systems with DDC of Individual Zone Terminals): Reset static-pressure set point based on the zone requiring the most pressure; reset set point lower until one zone damper is nearly wide open.
- 3) Set variable-frequency drive to minimum speed when fan is stopped.

2. Fan Airflow:

a. Input:

- 1) Device: Airflow sensor.
- 2) Location: Supply duct.
- 3) Transference: DDC controller.

b. Output:

- 1) Device: DDC controller.

c. Action: Report supply-duct airflow.

3. High Pressure:

a. Input:

- 1) Device: Air pressure switch.
- 2) Location: Supply duct referenced to outside the duct.
- 3) Transference: DDC controller.

b. Output:

- 1) Device: Binary output; DDC controller.
- 2) Transference: Starter relay; operator's workstation.

c. Action: When static pressure rises above excessive-static-pressure set point of <Insert value>:

- 1) Stop fan.

- 2) Signal alarm.

D. Return Fan(s) Variable-Volume Control:

1. Fan Speed Control:

a. Input:

- 1) Device: Airflow sensor.
- 2) Location: Supply airstream and return airstream.
- 3) Transference: DDC controller.

b. Output:

- 1) Device: Analog output.
- 2) Location: Variable-frequency drive.
- 3) Transference: Variable-frequency drive controller.

c. Action:

- 1) Maintain constant airflow offset between supply- and return-air fans.
- 2) Set variable-frequency drive to minimum speed when fan is stopped.

2. Fan Speed Control:

a. Input:

- 1) Device: Air pressure differential transmitter.
- 2) Location: Indoor space static pressure referenced to outdoor static pressure.
- 3) Transference: DDC controller.

b. Output:

- 1) Device: Analog output.
- 2) Transference: Variable-frequency motor controller.

c. Action:

- 1) Maintain constant indoor static-pressure set point of 0.02-inch wg positive for outdoors.
- 2) Set variable-frequency drive to minimum speed when fan is stopped.

d. Action: Maintain constant indoor static pressure.

3. Discharge-Air Temperature:

a. Input:

- 1) Device: Air-temperature sensor with air-temperature RTD transmitter.
- 2) Location: Discharge airstream.
- 3) Transference: DDC controller.

b. Output:

- 1) Device: Analog output.

c. Action: Maintain air-temperature set point of 55 deg F.

E. Mixed-Air Control:

1. Minimum Position:

a. Input:

- 1) Device: DDC controller.
- 2) Location: Time schedule.
- 3) Transference: DDC controller.

b. Input:

- 1) Device: Flow measuring station.
- 2) Location: Outdoor-air intake.
- 3) Transference: DDC controller.

c. Output:

- 1) Device: Analog output.
- 2) Location: Outdoor damper.
- 3) Transference: Damper actuator(s).

d. Action:

- 1) Open outdoor-air dampers to minimum position.
- 2) Modulate outdoor-air dampers to maintain minimum airflow.

2. Heating Reset:

a. Input:

- 1) Device: DDC controller.
- 2) Location: Software.
- 3) Transference: DDC controller.

b. Output:

- 1) Device: Analog output.
- 2) Location: Outdoor dampers.
- 3) Transference: Damper actuator(s).

c. Action: Close minimum outdoor-air dampers.

3. Carbon Dioxide Reset:

a. Input:

- 1) Device: Carbon dioxide transmitter.
- 2) Location: Space.
- 3) Transference: DDC controller.

b. Output:

- 1) Device: Analog output.
    - 2) Location: Dampers.
    - 3) Transference: Damper actuator(s).
  - c. Action: Reset minimum outdoor-air damper position to maintain carbon dioxide set point of 500 PPM.
- 4. Cooling Reset:
  - a. Input:
    - 1) Device: Air-temperature sensor with air-temperature RTD transmitter and moisture sensor.
    - 2) Location: Outdoor- and return-air ducts.
    - 3) Input Transference: DDC controller.
  - b. Output:
    - 1) Device: Analog output.
    - 2) Location: Outdoor- and return-air ducts.
    - 3) Transference: Damper actuator(s).
  - c. Action: Set outdoor-air dampers to minimum position when outdoor-air enthalpy exceeds return-air enthalpy.

F. Filters:

- 1. Differential Pressure:
  - a. Input:
    - 1) Device: Pressure differential switch.
    - 2) Location: Filter bank.
    - 3) Transference: DDC controller.
  - b. Output:
    - 1) Device: DDC controller.
    - 2) Location: DDC controller.
    - 3) Transference: Operator's workstation.
  - c. Action: Signal alarm on high-pressure conditions.

1.7 TERMINAL UNIT OPERATING SEQUENCE

A. Cabinet Unit Heater, Electric:

- 1. Input:
  - a. Device: Line-voltage thermostat.
  - b. Location: Occupied space.
- 2. Output:
  - a. Device: Hard wired.

- b. Location: Motor-controller and heater relay.
    - c. Transference: Starter relay.
  - 3. Action: Cycle fan to maintain 70 deg F space temperature.
- B. Unit Heater, Electric: Space thermostat cycles fan and sequences stages of heating.
  - 1. Space Temperature:
    - a. Input:
      - 1) Device: Electric multistage thermostat.
      - 2) Location: Space.
    - b. Output:
      - 1) Device: Hard wired.
      - 2) Location: Unit control panel.
      - 3) Transference: Electric multistage contactors.
    - c. Action: Sequence electric coil stages to maintain 70 deg F space temperature.
- C. Heating Coils, Electric:
  - 1. Space Temperature:
    - a. Input:
      - 1) Device: Electric thermostat.
      - 2) Location: Space.
      - 3) Transference: Low-voltage control.
    - b. Output:
      - 1) Device: Pilot relays.
      - 2) Location: Heating-coil electrical cabinet.
      - 3) Transference: Line-voltage relays.
    - c. Action: Sequence stages of heating to maintain 70 deg F space temperature.
- D. Radiators and Convectors, Electric:
  - 1. Space Temperature:
    - a. Input:
      - 1) Device: Electric thermostat.
      - 2) Location: Space.
      - 3) Transference: Low-voltage control.
    - b. Output:
      - 1) Device: Pilot relays.
      - 2) Location: Radiator electrical cabinet.
      - 3) Transference: Line-voltage relays.

- c. Action: Sequence stages of heating to maintain 70 deg F space temperature set point.

E. Variable-Air-Volume Terminal Air Units with Electric Coils:

1. Space Temperature:

a. Input:

- 1) Device: Air-temperature sensor.
- 2) Location: Space.
- 3) Transference: DDC controller.

b. Output:

- 1) Device: Analog output.
- 2) Location: Control damper.
- 3) Input Transference: Control damper.

c. Action: Modulate damper and/or electric heating coil to maintain the following space temperature set points:

- 1) Occupied Cooling Temperature: 75 deg F.
- 2) Occupied Heating Temperature: 70 deg F.
- 3) Unoccupied Cooling Temperature: 80 deg F.
- 4) Unoccupied Heating Temperature: 65 deg F.
- 5) Modulate damper actuator from full open to minimum position.
- 6) When damper is at minimum position, energize electric heating coil.
- 7) Reverse the sequence for full heating to full cooling.

2. Variable-Air-Volume Terminal Air Units with Electric Heating Coil:

- a. Space/area served.
- b. Space occupied/unoccupied.
- c. Space temperature indication.
- d. Space temperature set point.
- e. Space cooling and heating temperature set point, occupied.
- f. Space cooling and heating temperature set point, unoccupied.
- g. Air-damper position as percentage open.

1.8 VENTILATION SEQUENCES

A. Makeup Unit Control, Gas:

1. Initiation:

a. Input:

- 1) Device: Auxiliary contact.
- 2) Location: Served appliance.

b. Output:

- 1) Device: Hard wired.
- 2) Location: Served appliance.



- 3) Transference: Starter relay and electric solenoid.
  - c. Action: Start fan when appliance burner starts.
2. Space Temperature:
- a. Input:
    - 1) Device: Electronic multistage thermostat.
    - 2) Location: Space.
  - b. Output:
    - 1) Device: Hard wired.
    - 2) Location: Unit control panel.
    - 3) Transference: Electric multistage contactors.
  - c. Action: Sequence gas burner to maintain 60 deg F.
- B. Gravity Roof Ventilator:
- 1. Input:
    - a. Device: Pressure sensor.
    - b. Location: Space.
  - 2. Output:
    - a. Device: Hard wired.
    - b. Location: Control damper.
    - c. Transference: Damper actuator.
  - 3. Action: Open control damper when space pressure exceeds setpoint.
- C. Exhaust Fan: Room thermostat.
- 1. Input:
    - a. Device: Electric thermostat.
    - b. Location: Space.
  - 2. Output:
    - a. Device: Hard wired.
    - b. Location: Motor controller.
    - c. Transference: Starter relay.
  - 3. Action: Cycle fan on when space temperature rises above set point.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION

## SECTION 23 11 23

### FACILITY NATURAL-GAS PIPING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Pipes, tubes, and fittings.
  - 2. Piping specialties.
  - 3. Joining materials.
  - 4. Manual gas shutoff valves.
  - 5. Pressure regulators.
  - 6. Dielectric fittings.

##### 1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. An example includes rooftop locations.
- C. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- D. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

##### 1.4 ACTION SUBMITTALS

- A. Product Data:
  - 1. Piping specialties.
  - 2. Corrugated, stainless steel tubing with associated components.
  - 3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
  - 4. Pressure regulators. Indicate pressure ratings and capacities.
  - 5. Dielectric fittings.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
- B. Certificates:
  - 1. Welding certificates.
- C. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.
- D. Field Quality-Control Submittals:
  - 1. Field quality-control reports.
- E. Qualification Statements: For professional engineer.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pressure regulators to include in emergency, operation, and maintenance manuals.

## 1.7 QUALITY ASSURANCE

- A. Qualifications:
  - 1. Steel Support Welding: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  - 2. Pipe Welding: Qualify procedures and operators in accordance with the ASME Boiler and Pressure Vessel Code.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping in accordance with requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

## 1.9 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

## 1.10 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed and concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."
- C. Coordinate requirements for piping identification for natural-gas piping. Comply with requirements in Section 220553 "Identification of Plumbing Piping and Equipment."

## PART 2 - PRODUCTS

### 2.1 SOURCE LIMITATIONS

- A. Obtain each product type from single source from single manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 54 and the International Fuel Gas Code.
- B. Minimum Operating-Pressure Ratings:
  - 1. Piping and Valves: 100 psig (690 kPa) minimum unless otherwise indicated.
  - 2. Service Regulators: 100 psig (690 kPa) minimum unless otherwise indicated.
  - 3. Minimum Operating Pressure of Service Meter: 5 psig (34.5 kPa).
- C. Natural-Gas System Pressure within Buildings:
  - 1. Two pressure ranges. Primary pressure is more than 0.5 psig (3.45 kPa), but not more than 2 psig (13.8 kPa), and is reduced to secondary pressure of 0.5 psig (3.45 kPa) or less.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Seismic Performance: Natural-gas piping system is to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7. See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
  - 1. The term "withstand" means "the piping system will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the piping system will be fully operational after the seismic event."
  - 2. Component Importance Factor: 1.5.

### 2.3 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
  - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
  - 2. Wrought-Steel Welding Fittings: ASTM A234/A234M for butt welding and socket welding.
  - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
    - a. Material Group: 1.1.
    - b. End Connections: Threaded or butt welding to match pipe.
    - c. Lapped Face: Not permitted underground.
    - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum O-rings, and spiral-wound metal gaskets.
    - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
  5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
    - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
  6. Mechanical Couplings:
    - a. Stainless steel flanges and tube with epoxy finish.
    - b. NBR seals.
    - c. Stainless steel bolts, washers, and nuts.
    - d. Coupling is to be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
    - e. Steel body couplings installed underground on plastic pipe are to be factory equipped with anode.
- B. Corrugated, Stainless Steel Tubing: Comply with ANSI/IAS LC 1/CSA 6.26.
1. Tubing: ASTM A240/A240M, corrugated, Series 300 stainless steel.
  2. Coating: PE with flame retardant.
    - a. Surface-Burning Characteristics: As determined by testing identical products in accordance with ASTM E84 by qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      - 1) Flame-Spread Index: 25 or less.
      - 2) Smoke-Developed Index: 50 or less.
  3. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
  4. Striker Plates: Steel, designed to protect tubing from penetrations.
  5. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections are to comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
  6. Operating-Pressure Rating: 5 psig (34.5 kPa).
- C. Aluminum Tubing: Comply with ASTM B210 and ASTM B241/B241M.
1. Aluminum Alloy: Alloy 5456 is prohibited.
  2. Protective Coating: Factory-applied coating capable of resisting corrosion on tubing in contact with masonry, plaster, insulation, water, detergents, and sewerage.
  3. Flare Fittings: Comply with ASME B16.26 and SAE J513.
    - a. Copper-alloy fittings.
    - b. Metal-to-metal compression seal without gasket.
    - c. Dryseal threads complying with ASME B1.20.3.

- D. Drawn-Temper Copper Tube: Comply with ASTM B88, Type K (ASTM B88M, Type A).
1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
  2. Bronze Flanges and Flanged Fittings: ASME B16.24, Class 150.
    - a. Gasket Material: ASME B16.20, metallic, flat, asbestos free, aluminum O-rings, and spiral-wound metal gaskets.
    - b. Bolts and Nuts: ASME B18.2.1, carbon steel or stainless steel.
  3. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch (0.56 mm) thick.
- E. Annealed-Temper Copper Tube: Comply with ASTM B88, Type K (ASTM B88M, Type A).
1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
  2. Flare Fittings: Comply with ASME B16.26 and SAE J513.
    - a. Copper fittings with long nuts.
    - b. Metal-to-metal compression seal without gasket.
    - c. Dryseal threads complying with ASME B1.20.3.
  3. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch (0.56 mm) thick.
- F. Tin-Lined Copper Tube: ASTM B280, seamless, annealed, with interior tin-plated lining.
1. Flare Fittings: Comply with ASME B16.26 and SAE J513.
    - a. Copper fittings with long nuts.
    - b. Metal-to-metal compression seal without gasket.
    - c. Dryseal threads complying with ASME B1.20.3.
- G. PE Pipe: ASTM D2513, SDR 11.
1. PE Fittings: ASTM D2683, socket-fusion type or ASTM D3261, butt-fusion type with dimensions matching PE pipe.
  2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D2513, SDR 11; and steel pipe complying with ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
  3. Anodeless Service-Line Risers: Factory fabricated and leak tested.
    - a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet.
    - b. Casing: Steel pipe complying with ASTM A53/A53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering.
    - c. Aboveground Portion: PE transition fitting.
    - d. Outlet is threaded or flanged or suitable for welded connection.
    - e. Tracer wire connection.
    - f. UV shield.
    - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
  4. Transition Service-Line Risers: Factory fabricated and leak tested.
    - a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet connected to steel pipe complying with ASTM A53/A53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.

- b. Outlet is threaded or flanged or suitable for welded connection.
  - c. Bridging sleeve over mechanical coupling.
  - d. Factory-connected anode.
  - e. Tracer wire connection.
  - f. UV shield.
  - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
5. Plastic Mechanical Couplings, NPS 1-1/2 (DN 40) and Smaller: Suitable for joining PE pipe to PE pipe.
    - a. PE body with molded-in, stainless steel support ring.
    - b. Seals: NBR.
    - c. Acetal collets.
    - d. Electro-zinc-plated steel stiffener.
  6. Plastic Mechanical Couplings, NPS 2 (DN 50) and Larger: Suitable for joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
    - a. Fiber-reinforced plastic body.
    - b. PE body tube.
    - c. Seals: NBR.
    - d. Acetal collets.
    - e. Stainless steel bolts, nuts, and washers.
  7. Steel Mechanical Couplings: Suitable for joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
    - a. Stainless steel flanges and tube with epoxy finish.
    - b. Seals: NBR.
    - c. Stainless steel bolts, washers, and nuts.
    - d. Factory-installed anode for steel-body couplings installed underground.

## 2.4 PIPING SPECIALTIES

### A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated, stainless steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig (3.45 kPa).
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches (1830 mm).

### B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Seals: Nitrile.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

### C. Y-Pattern Strainers:

1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless steel basket with 50 percent free area.
4. CWP Rating: 125 psig (862 kPa).

D. Basket Strainers:

1. Body: ASTM A126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless steel basket with 50 percent free area.
4. CWP Rating: 125 psig (862 kPa).

E. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless steel basket with 57 percent free area.
4. CWP Rating: 750 psig (5170 kPa).

F. Weatherproof Vent Cap:

1. Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

## 2.5 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F (540 deg C) complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

## 2.6 MANUAL GAS SHUTOFF VALVES

- A. See "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller: Comply with ASME B16.33.
  1. CWP Rating: 125 psig (862 kPa).
  2. Threaded Ends: Comply with ASME B1.20.1.
  3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.



4. Tamperproof Feature: Locking feature for valves indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
  5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
  6. Service Mark: Valves NPS 1-1/4 to NPS 2 (DN 32 to DN 50) having initials "WOG" permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 (DN 65) and Larger: Comply with ASME B16.38.
1. CWP Rating: 125 psig (862 kPa).
  2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
  3. Tamperproof Feature: Locking feature for valves indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
  4. Service Mark: Initials "WOG" permanently marked on valve body.
- D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
1. Body: Bronze, complying with ASTM B584.
  2. Ball: Chrome-plated brass.
  3. Stem: Bronze; blowout proof.
  4. Seats: Reinforced TFE; blowout proof.
  5. Packing: Separate packnut with adjustable-stem packing threaded ends.
  6. Ends: Threaded, flared, or socket as indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
  7. CWP Rating: 600 psig (4140 kPa).
  8. Listing: Valves NPS 1 (DN 25) and smaller are to be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- E. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Body: Bronze, complying with ASTM B584.
  2. Ball: Chrome-plated bronze.
  3. Stem: Bronze; blowout proof.
  4. Seats: Reinforced TFE; blowout proof.
  5. Packing: Threaded-body packnut design with adjustable-stem packing.
  6. Ends: Threaded, flared, or socket as indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
  7. CWP Rating: 600 psig (4140 kPa).
  8. Listing: Valves NPS 1 (DN 25) and smaller are to be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- F. Bronze Plug Valves: MSS SP-78.
1. Body: Bronze, complying with ASTM B584.
  2. Plug: Bronze.
  3. Ends: Threaded, socket, or flanged as indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
  4. Operator: Square head or lug type with tamperproof feature where indicated.
  5. Pressure Class: 125 psig (862 kPa).
  6. Listing: Valves NPS 1 (DN 25) and smaller are to be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  7. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- G. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.

1. Body: Cast iron, complying with ASTM A126, Class B.
2. Plug: Bronze or nickel-plated cast iron.
3. Seat: Coated with thermoplastic.
4. Stem Seal: Compatible with natural gas.
5. Ends: Threaded or flanged as indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
6. Operator: Square head or lug type with tamperproof feature where indicated.
7. Pressure Class: 125 psig (862 kPa).
8. Listing: Valves NPS 1 (DN 25) and smaller are to be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

H. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

1. Body: Cast iron, complying with ASTM A126, Class B.
2. Plug: Bronze or nickel-plated cast iron.
3. Seat: Coated with thermoplastic.
4. Stem Seal: Compatible with natural gas.
5. Ends: Threaded or flanged as indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
6. Operator: Square head or lug type with tamperproof feature where indicated.
7. Pressure Class: 125 psig (862 kPa).
8. Listing: Valves NPS 1 (DN 25) and smaller are to be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

I. PE Ball Valves: Comply with ASME B16.40.

1. Body: PE.
2. Ball: PE.
3. Stem: Acetal.
4. Seats and Seals: Nitrile.
5. Ends: Plain or fusible to match piping.
6. CWP Rating: 80 psig (552 kPa).
7. Operating Temperature: Minus 20 to plus 140 deg F (Minus 29 to plus 60 deg C).
8. Operator: Nut or flat head for key operation.
9. Include plastic valve extension.
10. Include tamperproof locking feature for valves where indicated on Drawings.

J. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches (125 mm) in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

## 2.7 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller; flanged for regulators NPS 2-1/2 (DN 65) and larger.

- B. Service Pressure Regulators: Comply with ANSI Z21.80A.
  - 1. Body and Diaphragm Case: Cast iron or die-cast aluminum.
  - 2. Springs: Zinc-plated steel; interchangeable.
  - 3. Diaphragm Plate: Zinc-plated steel.
  - 4. Seat Disc: NBR; resistant to gas impurities, abrasion, and deformation at the valve port.
  - 5. Orifice: Aluminum; interchangeable.
  - 6. Seal Plug: UV-stabilized, mineral-filled nylon.
  - 7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to regulator.
  - 8. Pressure regulator is to maintain discharge pressure setting downstream and is to not exceed 150 percent of design discharge pressure at shutoff.
  - 9. Overpressure Protection Device: Factory mounted on pressure regulator.
  - 10. Atmospheric Vent: Factory- or field-installed, stainless steel screen in opening if not connected to vent piping.
  - 11. Maximum Inlet Pressure: 100 psig (690 kPa).
  
- C. Line Pressure Regulators: Comply with ANSI Z21.80A.
  - 1. Body and Diaphragm Case: Cast iron or die-cast aluminum.
  - 2. Springs: Zinc-plated steel; interchangeable.
  - 3. Diaphragm Plate: Zinc-plated steel.
  - 4. Seat Disc: NBR; resistant to gas impurities, abrasion, and deformation at the valve port.
  - 5. Orifice: Aluminum; interchangeable.
  - 6. Seal Plug: UV-stabilized, mineral-filled nylon.
  - 7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to regulator.
  - 8. Pressure regulator is to maintain discharge pressure setting downstream and is to not exceed 150 percent of design discharge pressure at shutoff.
  - 9. Overpressure Protection Device: Factory mounted on pressure regulator.
  - 10. Atmospheric Vent: Factory- or field-installed, stainless steel screen in opening if not connected to vent piping.
  - 11. Maximum Inlet Pressure: 2 psig (13.8 kPa).
  
- D. Appliance Pressure Regulators: Comply with ANSI Z21.18.
  - 1. Body and Diaphragm Case: Die-cast aluminum.
  - 2. Springs: Zinc-plated steel; interchangeable.
  - 3. Diaphragm Plate: Zinc-plated steel.
  - 4. Seat Disc: NBR.
  - 5. Seal Plug: UV-stabilized, mineral-filled nylon.
  - 6. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
  - 7. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
  - 8. Maximum Inlet Pressure: 2 psig (13.8 kPa).

## 2.8 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
  
- B. Dielectric Unions:
  - 1. Description:
    - a. Standard: ASSE 1079.
    - b. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
    - c. End Connections: Solder-joint copper alloy and threaded ferrous.

- C. Dielectric Flanges:
  - 1. Description:
    - a. Standard: ASSE 1079.
    - b. Factory-fabricated, bolted, companion-flange assembly.
    - c. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
    - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
  - 1. Description:
    - a. Nonconducting materials for field assembly of companion flanges.
    - b. Pressure Rating: 150 psig (1035 kPa).
    - c. Gasket: Neoprene or phenolic.
    - d. Bolt Sleeves: Phenolic or polyethylene.
    - e. Washers: Phenolic with steel backing washers.

## 2.9 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description and rated pressure of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored yellow.
- B. Label and identify gas piping and pressure outside a multitenant building by tenant.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Inspect natural-gas piping in accordance with NFPA 54 and the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- B. Comply with NFPA 54 and the International Fuel Gas Code requirements for preventing accidental ignition.

### 3.3 INSTALLATION OF OUTDOOR PIPING

- A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.

- B. Install underground, natural-gas piping buried at least 36 inches (900 mm) below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.
  - 1. If natural-gas piping is installed less than 36 inches (900 mm) below finished grade, install it in containment conduit.
- C. Install underground, PE, natural-gas piping in accordance with ASTM D2774.
- D. Steel Piping with Protective Coating:
  - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
  - 2. Replace pipe having damaged PE coating with new pipe.
- E. Copper Tubing with Protective Coating:
  - 1. Apply joint cover kits over tubing to cover, seal, and protect joints.
  - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
- F. Install fittings for changes in direction and branch connections.
- G. Install pressure gauge upstream and downstream from each service regulator. Pressure gauges are specified in Section 230519 "Meters and Gauges for HVAC Piping."

#### 3.4 INSTALLATION OF INDOOR PIPING

- A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Do not install piping in concealed locations unless sleeved with the sleeve open at both ends.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Where installing piping above accessible ceilings, allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access. Do not locate valves within return air plenums.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.

- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
  - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
  - 1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
  - 2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches (38 mm) of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
  - 3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
  - 4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
    - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
  - 5. Prohibited Locations:
    - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    - b. Do not install natural-gas piping in solid walls or partitions.
- Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- R. Connect branch piping from top or side of horizontal piping.
- S. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

- T. Do not use natural-gas piping as grounding electrode.
- U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- V. Install pressure gauge upstream and downstream from each line regulator. Pressure gauges are specified in Section 230519 "Meters and Gauges for HVAC Piping."
- W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

### 3.5 INSTALLATION OF VALVES

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless steel tubing, aluminum, or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Install earthquake valves aboveground outside buildings according to listing.
- E. Install anode for metallic valves in underground PE piping.
- F. Do not install valves in return-air plenums.

### 3.6 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
  1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
  2. Cut threads full and clean using sharp dies.
  3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
  4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
  5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:

1. Construct joints in accordance with AWS D10.12/D10.12M, using qualified processes and welding operators.
  2. Bevel plain ends of steel pipe.
  3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Brazed Joints: Construct joints in accordance with AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
- F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
- G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, and then use wrench. Do not overtighten.
- H. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join in accordance with ASTM D2657.
1. Plain-End Pipe and Fittings: Use butt fusion.
  2. Plain-End Pipe and Socket Fittings: Use socket fusion.

### 3.7 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.
- C. Install hangers for steel piping and copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Install hangers for corrugated stainless steel tubing, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- E. Support horizontal piping within 12 inches (300 mm) of each fitting.
- F. Support vertical runs of steel piping and copper tubing to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- G. Support vertical runs of corrugated stainless steel tubing to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

### 3.8 PIPING CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas-appliance equipment grounding conductor of the circuit powering the appliance in accordance with NFPA 70.



- C. Where installing piping adjacent to appliances, allow space for service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

### 3.9 LABELING AND IDENTIFICATION

- A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.

### 3.10 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base in accordance with seismic codes at Project. See Section 230548 "Vibration and Seismic Controls for HVAC."
  - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
  - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 6. Use 3000 psig (20.7 MPa), 28-day, compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

### 3.11 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. Test, inspect, and purge natural gas in accordance with NFPA 54 and the International Fuel Gas Code and authorities having jurisdiction.
  - 2. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- B. Prepare test and inspection reports.

### 3.12 OUTDOOR PIPING SCHEDULE

- A. Underground natural-gas piping is to be one of the following:
  - 1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
  - 2. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
- B. Aboveground natural-gas piping is to be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

3.13 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG (3.45 kPa)

- A. Aboveground, branch piping NPS 1 (DN 25) and smaller is to be one of the following:
1. Corrugated stainless steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
  2. Annealed-temper, tin-lined copper tube with flared joints and fittings.
  3. Annealed-temper, copper tube with wrought-copper fittings and brazed joints.
  4. Aluminum tube with flared fittings and joints.
  5. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping is to be one of the following:
1. Steel pipe with malleable-iron fittings and threaded joints.
  2. Steel pipe with wrought-steel fittings and welded joints.
  3. Drawn-temper copper tube with wrought-copper fittings and brazed joints.

3.14 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG (3.45 kPa) AND LESS THAN 5 PSIG (34.5 kPa)

- A. Aboveground, branch piping NPS 1 (DN 25) and smaller is to be one of the following:
1. Corrugated stainless steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
  2. Annealed-temper, tin-lined copper tube with flared joints and fittings.
  3. Annealed-temper copper tube with wrought-copper fittings and brazed joints.
  4. Aluminum tube with flared fittings and joints.
  5. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping is to be one of the following:
1. Steel pipe with malleable-iron fittings and threaded joints.
  2. Steel pipe with steel welding fittings and welded joints.
  3. Drawn-temper copper tube with wrought-copper fittings and brazed joints.

3.15 ABOVEGROUND, MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 2 (DN 50) and smaller at service meter are to be one of the following:
1. One-piece, bronze ball valve with bronze trim.
  2. Two-piece, full-port, bronze ball valves with bronze trim.
  3. Bronze plug valve.
- B. Valves for pipe sizes NPS 2-1/2 (DN 65) and larger at service meter are to be one of the following:
1. Two-piece, full-port, bronze ball valves with bronze trim.
  2. Bronze plug valve.
  3. Cast-iron, nonlubricated plug valve.

- C. Distribution piping valves for pipe sizes NPS 2 (DN 50) and smaller are to be one of the following:
  - 1. One-piece, bronze ball valve with bronze trim.
  - 2. Two-piece, full-port, bronze ball valves with bronze trim.
  - 3. Bronze plug valve.
  
- D. Distribution piping valves for pipe sizes NPS 2-1/2 (DN 65) and larger are to be one of the following:
  - 1. Two-piece, full-port, bronze ball valves with bronze trim.
  - 2. Bronze plug valve.
  - 3. Cast-iron, nonlubricated plug valve.
  
- E. Valves in branch piping for single appliance are to be one of the following:
  - 1. One-piece, bronze ball valve with bronze trim.
  - 2. Two-piece, full-port, bronze ball valves with bronze trim.
  - 3. Bronze plug valve.

END OF SECTION 23 11 23

## SECTION 232330

### REFRIGERANT PIPING

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Refrigerant pipes and fittings.
  - 2. Refrigerant piping valves and specialties.
  - 3. Refrigerants.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty.
  - 1. Include pressure drop, based on manufacturer's test data, for the following:
    - a. Thermostatic expansion valves.
    - b. Solenoid valves.
    - c. Hot-gas bypass valves.
    - d. Filter dryers.
    - e. Strainers.
    - f. Pressure-regulating valves.
- B. Shop Drawings:
  - 1. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; valve arrangements and locations; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.
  - 2. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
  - 3. Show interface and spatial relationships between piping and equipment.
  - 4. Shop Drawing Scale: 1/4 inch equals 1 foot.

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Field quality-control reports.

## 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

## 1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to 2010 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications." Refrigeration contractor must be certified installer for the installation of refrigerant piping systems and associated specificities required for Variable Refrigerant Flow (VRF) systems.
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

## 1.7 PRODUCT STORAGE AND HANDLING

- A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-410A:
  - 1. Suction Lines for Air-Conditioning Applications: 300 psig.
  - 2. Suction Lines for Heat-Pump Applications: 535 psig.
  - 3. Hot-Gas and Liquid Lines: 535 psig.

### 2.2 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88, Type K and L.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Brazing Filler Metals: AWS A5.8/A5.8M.
- E. Flexible Connectors:
  - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
  - 2. End Connections: Socket ends.
  - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
  - 4. Working Pressure Rating: Factory test at minimum 500 psig.
  - 5. Maximum Operating Temperature: 250 deg F.

### 2.3 VALVES AND SPECIALTIES

- A. Diaphragm Packless Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Danfoss Inc.
  - b. Heldon Products; Henry Technologies.
  - c. Parker Hannifin Corp.
  - d. Paul Mueller Company.
2. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
3. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
4. Operator: Rising stem and hand wheel.
5. Seat: Nylon.
6. End Connections: Socket, union, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

B. Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Danfoss Inc.
  - b. Emerson Climate Technologies.
  - c. Heldon Products; Henry Technologies.
  - d. Parker Hannifin Corp.
  - e. Paul Mueller Company.
2. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
3. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
4. Piston: Removable polytetrafluoroethylene seat.
5. Closing Spring: Stainless steel.
6. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
7. End Connections: Socket, union, threaded, or flanged.
8. Maximum Opening Pressure: 0.50 psig.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 275 deg F.

C. Service Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Danfoss Inc.
  - b. Emerson Climate Technologies.
  - c. Heldon Products; Henry Technologies.
  - d. Parker Hannifin Corp.
  - e. Paul Mueller Company.
  - f. Refrigeration Sales, Inc.
2. Body: Forged brass with brass cap including key end to remove core.
3. Core: Removable ball-type check valve with stainless-steel spring.
4. Seat: Polytetrafluoroethylene.
5. End Connections: Copper spring.
6. Working Pressure Rating: 500 psig.

- D. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Danfoss Inc.
    - b. Emerson Climate Technologies.
    - c. Heldon Products; Henry Technologies.
    - d. Parker Hannifin Corp.
    - e. Paul Mueller Company.
  2. Body and Bonnet: Plated steel.
  3. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
  4. Seat: Polytetrafluoroethylene.
  5. End Connections: Threaded.
  6. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 115 V ac coil.
  7. Working Pressure Rating: 400 psig.
  8. Maximum Operating Temperature: 240 deg F.
- E. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Danfoss Inc.
    - b. Heldon Products; Henry Technologies.
    - c. Parker Hannifin Corp.
    - d. Paul Mueller Company.
  2. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
  3. Piston, Closing Spring, and Seat Insert: Stainless steel.
  4. Seat: Polytetrafluoroethylene.
  5. End Connections: Threaded.
  6. Working Pressure Rating: 400 psig.
  7. Maximum Operating Temperature: 240 deg F.
- F. Thermostatic Expansion Valves: Comply with AHRI 750.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Danfoss Inc.
    - b. Emerson Climate Technologies.
    - c. Heldon Products; Henry Technologies.
    - d. Paul Mueller Company.
  2. Body, Bonnet, and Seal Cap: Forged brass or steel.
  3. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
  4. Packing and Gaskets: Non-asbestos.
  5. Capillary and Bulb: Copper tubing filled with refrigerant charge.
  6. Suction Temperature: 40 deg F.
  7. Superheat: Adjustable.

8. Reverse-flow option (for heat-pump applications).
9. End Connections: Socket, flare, or threaded union.
10. Working Pressure Rating: 450 psig.

G. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Danfoss Inc.
  - b. Heldon Products; Henry Technologies.
  - c. Parker Hannifin Corp.
2. Body, Bonnet, and Seal Cap: Ductile iron or steel.
3. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
4. Packing and Gaskets: Non-asbestos.
5. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
6. Seat: Polytetrafluoroethylene.
7. Equalizer: Internal or External.
8. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter and 115 V ac coil.
9. End Connections: Socket.
10. Throttling Range: Maximum 5 psig.
11. Working Pressure Rating: 500 psig.
12. Maximum Operating Temperature: 240 deg F.

H. Straight-Type Strainers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Danfoss Inc.
  - b. Heldon Products; Henry Technologies.
  - c. Parker Hannifin Corp.
2. Body: Welded steel with corrosion-resistant coating.
3. Screen: 100-mesh stainless steel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

I. Angle-Type Strainers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Danfoss Inc.
  - b. Heldon Products; Henry Technologies.
  - c. Parker Hannifin Corp.
2. Body: Forged brass or cast bronze.
3. Drain Plug: Brass hex plug.
4. Screen: 100-mesh monel.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.



7. Maximum Operating Temperature: 275 deg F.

J. Moisture/Liquid Indicators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Danfoss Inc.
  - b. Emerson Climate Technologies.
  - c. Heldon Products; Henry Technologies.
  - d. Parker Hannifin Corp.
2. Body: Forged brass.
3. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
4. Indicator: Color coded to show moisture content in parts per million (ppm).
5. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
6. End Connections: Socket or flare.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 240 deg F.

K. Replaceable-Core Filter Dryers: Comply with AHRI 730.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Danfoss Inc.
  - b. Emerson Climate Technologies.
  - c. Heldon Products; Henry Technologies.
  - d. Parker Hannifin Corp.
2. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
3. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
4. Desiccant Media: Activated alumina or charcoal.
5. Designed for reverse flow (for heat-pump applications).
6. End Connections: Socket.
7. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
8. Maximum Pressure Loss: 2 psig.
9. Rated Flow: 50 tons.
10. Working Pressure Rating: 500 psig.
11. Maximum Operating Temperature: 240 deg F.

L. Permanent Filter Dryers: Comply with AHRI 730.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Danfoss Inc.
  - b. Emerson Climate Technologies.
  - c. Heldon Products; Henry Technologies.
  - d. Parker Hannifin Corp.
2. Body and Cover: Painted-steel shell.

3. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
4. Desiccant Media: Activated alumina or charcoal.
5. Designed for reverse flow (for heat-pump applications).
6. End Connections: Socket.
7. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
8. Maximum Pressure Loss: 2 psig.
9. Rated Flow: 50 tons.
10. Working Pressure Rating: 500 psig.
11. Maximum Operating Temperature: 240 deg F.

M. Mufflers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Danfoss Inc.
  - b. Emerson Climate Technologies.
  - c. Heldon Products; Henry Technologies.
2. Body: Welded steel with corrosion-resistant coating.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

N. Receivers: Comply with AHRI 495.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Heldon Products; Henry Technologies.
2. Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
3. Comply with UL 207; listed and labeled by an NRTL.
4. Body: Welded steel with corrosion-resistant coating.
5. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
6. End Connections: Socket or threaded.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

O. Liquid Accumulators: Comply with AHRI 495.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Emerson Climate Technologies.
  - b. Heldon Products; Henry Technologies.
  - c. Parker Hannifin Corp.
2. Body: Welded steel with corrosion-resistant coating.
3. End Connections: Socket or threaded.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

## 2.4 REFRIGERANTS

- A. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arkema Inc.
    - b. DuPont Fluorochemicals Div.
    - c. Genetron Refrigerants; Honeywell International Inc.
    - d. Mexichem Fluor Inc.

## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

- A. Hot-Gas and Liquid Lines, and Suction Lines for Heat Pump Applications:
  - 1. NPS 5/8 and Smaller: Copper, Type L (B), annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
  - 2. NPS 3/4 to NPS 1 and Smaller: Copper, Type K (A), annealed or drawn-temper tubing and wrought-copper fittings with brazed joints.
  - 3. NPS 1-1/4 and Smaller: Copper, Type L (B), drawn-temper tubing and wrought-copper fittings.
- B. Safety-Relief-Valve Discharge Piping: Copper, Type L (B), annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
- C. Safety-Relief-Valve Discharge Piping: Copper, Type L (B), drawn-temper tubing and wrought-copper fittings.

### 3.2 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.
- E. Install a full-size, three-valve bypass around filter dryers.
- F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
- G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
  - 1. Install valve so diaphragm case is warmer than bulb.
  - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.

3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- H. Install safety relief valves where required by 2010 ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
- I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:
  1. Solenoid valves.
  2. Thermostatic expansion valves.
  3. Hot-gas bypass valves.
  4. Compressor.
- K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.
- L. Install receivers sized to accommodate pump-down charge.
- M. Install flexible connectors at compressors.

### 3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of VRF equipment and refrigerant piping systems. Refrigeration piping arrangements, piping footages and sizing were supplied by the Basis of Design VRF manufacturer. The refrigeration contractor shall be responsible for coordinating refrigerant piping design, routing and sizing based on the VRF equipment/systems submitted. The refrigeration contractor must be a factory trained and certified installer of the VRF equipment submitted. Install piping systems as indicated on the approved refrigeration shop drawing, and do not make any field deviations to layout unless approved by the VRF manufacturer.
- B. Install refrigerant piping according to ASHRAE 15 and per manufacturers' recommendations.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.

- J. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for solenoid valve controllers, control wiring, and sequence of operation.
- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in architectural division of the specification if valves or equipment requiring maintenance is concealed behind finished surfaces.
- M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- N. Slope refrigerant piping as follows:
  - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
  - 2. Install horizontal suction lines with a uniform slope downward to compressor.
  - 3. Install traps and double risers to entrain oil in vertical runs.
  - 4. Liquid lines may be installed level.
- O. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- P. Before installation of refrigerant piping, clean pipe and fittings using the following procedures:
  - 1. Shot blast the interior of piping.
  - 2. Remove coarse particles of dirt and dust by drawing a clean, lint less cloth through tubing by means of a wire or electrician's tape.
  - 3. Draw a clean, lint less cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
  - 4. Draw a clean, lint less cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
  - 5. Finally, draw a clean, dry, lint less cloth through the tube or pipe.
  - 6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.
- Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- R. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."
- S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

### 3.4 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
  - 1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
  - 2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.
- E. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and to restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.
- G. Welded Joints: Construct joints according to AWS D10.12M/D10.12.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

### 3.5 HANGERS AND SUPPORTS

- A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
  - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
  - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
  - 4. Spring hangers to support vertical runs.
  - 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod diameters:
  - 1. NPS 1/2: Maximum span, 60 inches; minimum rod, 1/4 inch.

2. NPS 5/8: Maximum span, 60 inches; minimum rod, 1/4 inch.
3. NPS 1: Maximum span, 72 inches; minimum rod, 1/4 inch.
4. NPS 1-1/4: Maximum span, 96 inches; minimum rod, 3/8 inch.
5. NPS 1-1/2: Maximum span, 96 inches; minimum rod, 3/8 inch.

D. Support multi floor vertical runs at least at each floor.

### 3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
  - a. Purge all refrigerant lines before testing.
  - b. Fill system with nitrogen to the required test pressure.
  - c. System shall maintain test pressure at the manifold gage throughout duration of test.
  - d. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
  - e. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

B. Prepare test and inspection reports as required to maintain VRF system warranties and as outlined on the manufacturers' checklist.

C. Coordinate with the manufacturer's representative to be present multiple times during construction to witness and inspect the installation of refrigerant piping.

D. Submit refrigeration piping "as built" drawings along with all test reports at project completion.

### 3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Charge per manufacturer's recommendations.
2. Install core in filter dryers after leak test but before evacuation.
3. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
4. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
5. Charge system with a new filter-dryer core in charging line.

### 3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
1. Open shutoff valves in condenser water circuit.
  2. Verify that compressor oil level is correct.
  3. Open compressor suction and discharge valves.
  4. Open refrigerant valves except bypass valves that are used for other purposes.
  5. Check open compressor motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION



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## SECTION 233113

### METAL DUCTS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

###### A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.

###### B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

##### 1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

##### 1.5 ACTION SUBMITTALS

###### A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

###### B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
  - a. Lighting fixtures.
  - b. Air outlets and inlets.
  - c. Speakers.
  - d. Sprinklers.
  - e. Access panels.
  - f. Perimeter moldings.

B. Welding certificates.

C. Field quality-control reports.

D. Leak Test Procedures: Including test pressures, ductwork system definition and method for approving each system.

E. Leak Test Manual: As indicated.

## 1.7 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
  - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
  - 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
- E. Mockups:
  - 1. Before installing duct systems, build mockups representing static-pressure classes in excess of 2-inch wg. Build mockups to comply with the following requirements, using materials indicated for the completed Work:
    - a. Five transverse joints.
    - b. One access door.
    - c. Two typical branch connections, each with at least one elbow.
    - d. Two typical flexible duct or flexible-connector connections for each duct and apparatus.
    - e. One 90-degree turn(s) with turning vanes.
    - f. One fire damper.
    - g. Perform leakage tests specified in "Field Quality Control" Article. Revise mockup construction and perform additional tests as required to achieve specified minimum acceptable results.
  - 2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal

Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Ductmate Industries, Inc.
    - b. Lindab Inc.
    - c. McGill AirFlow LLC.
    - d. MKT Metal Manufacturing.
    - e. SEMCO LLC.
    - f. Sheet Metal Connectors, Inc.
    - g. Spiral Manufacturing Co., Inc.

- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- 1. Transverse Joints in Ducts Larger Than 60 in Diameter: Flanged.

- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- 1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.

- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction

methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G90.
  - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- F. Factory- or Shop-Applied Antimicrobial Coating:
  - 1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.
  - 2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
  - 3. Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested according to ASTM D 3363.
  - 4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
  - 5. Shop-Applied Coating Color: Black.
  - 6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.
- G. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
  - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- H. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

## 2.4 DUCT LINER

- A. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Aeroflex USA, Inc.
    - b. Armacell LLC.
    - c. Rubatex International, LLC.
  - 2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
  - a. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - b. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Insulation Pins and Washers:
  1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
  2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
  1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
  2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
  3. Butt transverse joints without gaps, and coat joint with adhesive.
  4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
  5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
  6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
  7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
  8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
    - a. Fan discharges.
    - b. Intervals of lined duct preceding unlined duct.
    - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
  9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
    - a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
  10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other

buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

## 2.5 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Water-Based Joint and Seam Sealant:
  - 1. Application Method: Brush on.
  - 2. Solids Content: Minimum 65 percent.
  - 3. Shore A Hardness: Minimum 20.
  - 4. Water resistant.
  - 5. Mold and mildew resistant.
  - 6. VOC: Maximum 75 g/L (less water).
  - 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
  - 8. Service: Indoor or outdoor.
  - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- C. Flanged Joint Sealant: Comply with ASTM C 920.
  - 1. General: Single-component, acid-curing, silicone, elastomeric.
  - 2. Type: S.
  - 3. Grade: NS.
  - 4. Class: 25.
  - 5. Use: O.
  - 6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- E. Round Duct Joint O-Ring Seals:
  - 1. Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa) and shall be rated for 10-inch wg static-pressure class, positive or negative.
  - 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
  - 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

## 2.6 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."



- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
  - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
  - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
  - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

### PART 3 - EXECUTION

#### 3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.

- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

### 3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

### 3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

- A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease and sloped a minimum of 2 percent to drain grease back to the hood.
- B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 20 feet or as required by code in horizontal ducts, or as indicated on Drawings.
- C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

### 3.4 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
  - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 2. All ductwork shall be sealed to Seal Class A.
  - 3. Outdoor, Supply-Air Ducts: Seal Class A.
  - 4. Outdoor, Exhaust Ducts: Seal Class A.
  - 5. Outdoor, Return-Air Ducts: Seal Class A.
  - 6. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class A.
  - 7. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
  - 8. Unconditioned Space, Exhaust Ducts: Seal Class A.
  - 9. Unconditioned Space, Return-Air Ducts: Seal Class A.
  - 10. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class A.

11. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
12. Conditioned Space, Exhaust Ducts: Seal Class A.
13. Conditioned Space, Return-Air Ducts: Seal Class A.

### 3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  1. Where practical, install concrete inserts before placing concrete.
  2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
  4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### 3.6 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

### 3.7 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in the architectural sections of the specifications.

### 3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual."
2. A written leak test manual shall be prepared prior to construction outlining testing procedures, testing methods, acceptable criteria, leakage factor (F) calculations, and calculation of ductwork surface area for each test section for each system tested. Duct system layouts utilizing sheetmetal shop drawings shall be developed indicating each section to be tested showing surface areas, allowable leakages and test pressures. Include test form as defined by SMACNA with leakage class, leakage factor allowable leakage cfm listed for each test section. This manual shall be submitted for review and approval prior to starting any duct installation. This manual shall be updated during the construction process and expanded to include all test results, verifications, and approval sign-offs during actual testing
3. Devices, including access doors, sound attenuators, damper casings, sensors and test ports, that are installed in duct systems, shall be included as part of the duct systems leakage allowance and tested accordingly. Air leakage for equipment, such as fans, air handling units and terminal units, have been accounted for separately and equipment has been specified to meet specific air leakage criteria. Mechanical Contractor shall independently leak test equipment after installation to assure compliance with requirements and shall isolate this equipment during ductwork leak testing. As an alternate, equipment may be leak tested as part of duct system, provided that this is so noted on report forms and that leakage rate allowances for ductwork and equipment are identified separately on forms. If allowable leakage is percentage based, then follow Appendix C of SMACNA's "HVAC Air Duct Leakage Test Manual." Include calculation of total system ductwork surface area along with test section surface area calculations within test procedures submittal.
4. If tests show that ductwork leakage is greater than that allowed, ductwork shall be resealed/rewelded and retested until within allowable leakage. Perform rework at no additional cost. Tests will be witnessed, and results verified by Owner's commissioning agent and the Balancing Contractor.
5. If, by test, during testing and balancing of the systems or otherwise, pressure drops across ductwork fittings and duct-mounted devices furnished under other Sections are exceeded by 10 percent of the pressure drop ratings listed in the SMACNA HVAC Duct System Design Manual, inspect inside of ductwork fittings and devices, and report findings to Design Professional. If fittings and devices do not have access doors, cut inspection openings in ductwork and provide airtight access covers secured with sheet metal screws. Repair or replace fittings and devices, and retest until within allowable pressure drop. Perform rework at no additional cost.
6. If, by test, during testing and balancing of the systems or otherwise, airflow between airflow sources and termination points are exceeded by 10 percent of the allowable leakage airflow for each section in question, review duct system under scrutiny for excessive leakage. Testing and Balancing Contractor shall confirm accuracy and calibration of devices utilized to make measurements. If calibration is confirmed and measured airflow between airflow sources and termination points exceed allowable leakage by 10%, then repeat duct leakage testing at no additional cost. Repair or replace fittings and devices, and retest until within allowable leakage. Perform rework at no additional cost.
7. Submit a final test manual including procedures and all reports for each test certifying that the ductwork does not exceed the maximum allowable leakage.
8. Test the following systems:
  - a. Supply Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, totaling no less than 50 percent of total installed duct area for each designated pressure class.
  - b. Return Ducts with a Pressure Class of 1-Inch wg or Higher: Test representative duct sections, totaling no less than 50 percent of total installed duct area for each designated pressure class.

- c. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, totaling no less than 50 percent of total installed duct area for each designated pressure class.
      - d. Outdoor Air Ducts with a Pressure Class of 1-Inch wg or Higher: Test representative duct sections, totaling no less than 50 percent of total installed duct area for each designated pressure class.
    - 9. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
    - 10. Test for leaks before applying external insulation.
    - 11. Conduct tests at static pressures equal to maximum design pressure class of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
    - 12. Give **seven** days' advance notice for testing.
  - C. Duct System Cleanliness Tests:
    - 1. Visually inspect duct system to ensure that no visible contaminants are present.
    - 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
      - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
  - D. Duct system will be considered defective if it does not pass tests and inspections.
  - E. Prepare test and inspection reports.
- 3.9 DUCT CLEANING
- A. Clean new duct systems before testing, adjusting, and balancing.
  - B. Use service openings for entry and inspection.
    - 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
    - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
    - 3. Remove and reinstall ceiling to gain access during the cleaning process.
  - C. Particulate Collection and Odor Control:
    - 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
    - 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
  - D. Clean the following components by removing surface contaminants and deposits:
    - 1. Air outlets and inlets (registers, grilles, and diffusers).

2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, condensate drain pans, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.10 START UP

- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

A. Supply Ducts:

1. Ducts Connected to Fan Coil Units and Terminal Units:
  - a. Pressure Class: Positive 1-inch wg.
  - b. Minimum SMACNA Seal Class: A
  - c. SMACNA Leakage Class for Rectangular: 3 1%.
  - d. SMACNA Leakage Class for Round 3 1%.
2. Ducts Connected to Constant-Volume Air-Handling Units:
  - a. Pressure Class: Positive 1-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 3 1%.
  - d. SMACNA Leakage Class for Round: 3 1%.
3. Ducts Connected to Variable-Air-Volume Air-Handling Units:

- a. Pressure Class: Positive 3-inch wg.
  - b. Minimum SMACNA Seal Class: A
  - c. SMACNA Leakage Class for Rectangular: 3 1%.
  - d. SMACNA Leakage Class for Round: 3 1%.
4. Ducts Connected to Equipment Not Listed Above:
- a. Pressure Class: Positive 2-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 3 1%.
  - d. SMACNA Leakage Class for Round: 3 1%.
- B. Return Ducts:
1. Ducts Connected to Fan Coil Units:
- a. Pressure Class: Positive or negative 1-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 3 1%.
  - d. SMACNA Leakage Class for Round: 3 1%.
2. Ducts Connected to Air-Handling Units:
- a. Pressure Class: Positive or negative 2-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 3 1%.
  - d. SMACNA Leakage Class for Round: 3 1%.
3. Ducts Connected to Equipment Not Listed Above:
- a. Pressure Class: Positive or negative 2-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 3 1%.
  - d. SMACNA Leakage Class for Round: 3 1%.
- C. Exhaust Ducts:
1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
- a. Pressure Class: Negative 2-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 3 1%.
  - d. SMACNA Leakage Class for Round: 3 1%.
2. Ducts Connected to Air-Handling Units:
- a. Pressure Class: Positive or negative 2-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 3 1%.
  - d. SMACNA Leakage Class for Round: 3 1%.
3. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.
- a. Concealed: 16 gauge carbon steel.
  - b. Welded seams and joints.

- c. Pressure Class: Positive or negative 2-inch wg.
  - d. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
  - e. SMACNA Leakage Class: 3 1%.
4. Ducts Connected to Dishwasher Hoods:
- a. Type 304, stainless-steel sheet.
  - b. Concealed: No. 2D finish.
  - c. Welded seams and flanged joints with watertight EPDM gaskets.
  - d. Pressure Class: Positive or negative 2-inch wg.
  - e. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
  - f. SMACNA Leakage Class: 3 1%.
5. Ducts Connected to Equipment Not Listed Above:
- a. Pressure Class: Positive or negative 3-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 3 1%.
- D. Outdoor Ducts:
1. Ducts Connected to Fan Coil Units:
- a. Pressure Class: Positive or negative 1-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 3 1%.
  - d. SMACNA Leakage Class for Round: 3 1%.
2. Ducts Connected to Air-Handling Units:
- a. Pressure Class: Positive or negative 1-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 3 1%.
  - d. SMACNA Leakage Class for Round: 3 1%.
3. Ducts Connected to Equipment Not Listed Above:
- a. Pressure Class: Positive or negative 2-inch wg.
  - b. Minimum SMACNA Seal Class: A.
  - c. SMACNA Leakage Class for Rectangular: 3 1%.
  - d. SMACNA Leakage Class for Round: 3 1%.
- E. Intermediate Reinforcement:
- 1. Galvanized-Steel Ducts: Galvanized steel.
  - 2. Aluminum Ducts: Aluminum.
- F. Liner:
- 1. Supply Air Ducts: Flexible elastomeric, 1 inch thick.
  - 2. Return Air Ducts: Flexible elastomeric, 1 inch thick.
  - 3. Exhaust Air Ducts: Flexible elastomeric, Type I, 1 inch thick.
  - 4. Supply Fan Plenums: Flexible elastomeric, 1 inch thick.
  - 5. Return and Exhaust-Fan Plenums: Flexible elastomeric, 2 inches thick.
  - 6. Transfer Ducts: Flexible elastomeric, ½" inch thick.



G. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
  - a. Velocity 1000 fpm or Lower:
    - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
    - 2) Mitered Type RE 4 without vanes.
  - b. Velocity 1000 to 1500 fpm:
    - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
    - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
    - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
  - c. Velocity 1500 fpm or Higher:
    - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
    - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
    - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
  - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
  - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
  - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
  - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
    - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
    - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
    - 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
    - 4) Radius-to Diameter Ratio: 1.5.
  - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
  - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

H. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
  - a. Rectangular Main to Rectangular Branch: 45-degree entry.
  - b. Rectangular Main to Round Branch: Spin in.
  
2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
  - a. Velocity 1000 fpm or Lower: 90-degree tap.
  - b. Velocity 1000 to 1500 fpm: Conical tap.
  - c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION

## SECTION 233300

### AIR DUCT ACCESSORIES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

###### A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Barometric relief dampers.
3. Manual volume dampers.
4. Control dampers.
5. Fire dampers.
6. Fire/Smoke dampers.
7. Flange connectors.
8. Turning vanes.
9. Duct-mounted access doors.
10. Flexible connectors.
11. Flexible ducts.
12. Duct accessory hardware.

###### B. Related Requirements:

1. Section 233723 "HVAC Gravity Ventilators" for roof-mounted ventilator caps.

##### 1.4 ACTION SUBMITTALS

###### A. Product Data: For each type of product.

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

###### B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances, and method of field assembly into duct systems and other construction. Include the following:

- a. Special fittings.
- b. Manual volume damper installations.

- c. Control-damper installations.
- d. Fire-damper and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
- e. Wiring Diagrams: For power, signal, and control wiring.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
- B. Source quality-control reports.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

### PART 2 - PRODUCTS

#### 2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

#### 2.2 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G90.
  - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- C. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

## 2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. American Warming and Ventilating; a Mestek Architectural Group company.
  - 2. Cesco Products; a division of MESTEK, Inc.
  - 3. Greenheck Fan Corporation.
  - 4. Nailor Industries Inc.
  - 5. Pottorff.
  - 6. Ruskin Company.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 1000 fpm
- D. Maximum System Pressure: 1-inch wg and 2-inch wg.
- E. Frame: Hat-shaped, 0.05-inch-thick, galvanized sheet steel 0.094-inch-thick, with welded corners or mechanically attached and mounting flange.
- F. Blades: Multiple single-piece blades, end pivoted, maximum 6-inch width, 0.025-inch-thick, roll-formed aluminum noncombustible, with sealed edges.
- G. Blade Action: Parallel.
- H. Blade Seals: Neoprene, mechanically locked.
- I. Blade Axles:
  - 1. Material: Galvanized steel
  - 2. Diameter: 0.20 inch.
- J. Tie Bars and Brackets: Galvanized steel.
- K. Return Spring: Adjustable tension.
- L. Bearings: Steel ball or synthetic pivot bushings.
- M. Accessories:
  - 1. Adjustment device to permit setting for varying differential static pressure.
  - 2. Counterweights and spring-assist kits for vertical airflow installations.
  - 3. Electric actuators.
  - 4. Chain pulls.
  - 5. Screen Mounting: Front mounted in sleeve.
    - a. Sleeve Thickness: 20 gage minimum.
    - b. Sleeve Length: 6 inches minimum.
  - 6. Screen Mounting: Rear mounted.
  - 7. Screen Material: Galvanized steel.
  - 8. Screen Type: Insect.
  - 9. 90-degree stops.

## 2.4 BAROMETRIC RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. American Warming and Ventilating; a Mestek Architectural Group company.
  - 2. Cesco Products; a division of MESTEK, Inc.
  - 3. Greenheck Fan Corporation.
  - 4. Nailor Industries Inc.
  - 5. Pottorff.
  - 6. Ruskin Company.
- B. Suitable for horizontal or vertical mounting.
- C. Maximum Air Velocity: 1250 fpm.
- D. Maximum System Pressure: 2-inch wg.
- E. Frame: Hat-shaped, 0.05-inch-thick, galvanized sheet steel with welded corners or mechanically attached and mounting flange.
- F. Blades:
  - 1. Multiple, 0.025-inch-thick, roll-formed aluminum.
  - 2. Maximum Width: 6 inches.
  - 3. Action: Parallel.
  - 4. Balance: Gravity.
  - 5. End pivoted.
- G. Blade Seals: Neoprene.
- H. Blade Axles: Galvanized steel.
- I. Tie Bars and Brackets:
  - 1. Material: Galvanized steel.
  - 2. Rattle free with 90-degree stop.
- J. Return Spring: Adjustable tension.
- K. Bearings: Synthetic.
- L. Accessories:
  - 1. Flange on intake.
  - 2. Adjustment device to permit setting for varying differential static pressures.

## 2.5 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Warming and Ventilating; a Mestek Architectural Group company.

- b. Flexmaster U.S.A., Inc.
  - c. McGill AirFlow LLC.
  - d. Nailor Industries Inc.
  - e. Pottorff.
  - f. Ruskin Company.
  - g. Vent Products Co., Inc.
2. Standard leakage rating.
  3. Suitable for horizontal or vertical applications.
  4. Frames:
    - a. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel.
    - b. Mitered and welded corners.
    - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
  5. Blades:
    - a. Multiple or single blade.
    - b. Parallel- or opposed-blade design.
    - c. Stiffen damper blades for stability.
    - d. Galvanized-steel, 0.064 inch thick.
  6. Blade Axles: Galvanized steel.
  7. Bearings:
    - a. Oil-impregnated bronze.
    - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
  8. Tie Bars and Brackets: Galvanized steel.
- B. Standard, Aluminum, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Warming and Ventilating; a Mestek Architectural Group company.
    - b. McGill AirFlow LLC.
    - c. Nailor Industries Inc.
    - d. Pottorff.
    - e. Ruskin Company.
    - f. Vent Products Co., Inc.
  2. Standard leakage rating.
  3. Suitable for horizontal or vertical applications.
  4. Frames: Hat-shaped, 0.10-inch-thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
  5. Blades:
    - a. Multiple or single blade.
    - b. Parallel- or opposed-blade design.
    - c. Stiffen damper blades for stability.
    - d. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.
    - e. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.

6. Blade Axles: Galvanized steel.
7. Bearings:
  - a. Molded synthetic.
  - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Aluminum.

C. Low-Leakage, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Warming and Ventilating; a Mestek Architectural Group company.
  - b. McGill AirFlow LLC.
  - c. Nailor Industries Inc.
  - d. Pottorff.
  - e. Ruskin Company.
  - f. Vent Products Co., Inc.
2. Comply with AMCA 500-D testing for damper rating.
3. Low-leakage rating and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
4. Suitable for horizontal or vertical applications.
5. Frames:
  - a. Hat shaped.
  - b. 0.094-inch-thick, galvanized sheet steel] [0.05-inch-thick stainless steel.
  - c. Mitered and welded corners.
  - d. Flanges for attaching to walls and flangeless frames for installing in ducts.
6. Blades:
  - a. Multiple or single blade.
  - b. Parallel- or opposed-blade design.
  - c. Stiffen damper blades for stability.
  - d. Galvanized, roll-formed steel, 0.064 inch thick.
7. Blade Axles: Galvanized steel.
8. Bearings:
  - a. Molded synthetic.
  - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
9. Blade Seals: Neoprene.
10. Jamb Seals: Cambered stainless steel.
11. Tie Bars and Brackets: Galvanized steel.
12. Accessories:
  - a. Include locking device to hold single-blade dampers in a fixed position without vibration.

D. Low-Leakage, Aluminum, Manual Volume Dampers:



1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Warming and Ventilating; a Mestek Architectural Group company.
  - b. McGill AirFlow LLC.
  - c. Nailor Industries Inc.
  - d. Pottorff.
  - e. Ruskin Company.
  - f. Trox USA Inc.
  - g. Vent Products Co., Inc.
2. Comply with AMCA 500-D testing for damper rating.
3. Low-leakage rating and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
4. Suitable for horizontal or vertical applications.
5. Frames: Hat shaped, 0.10-inch-thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
6. Blades:
  - a. Multiple or single blade.
  - b. Parallel- or opposed-blade design.
  - c. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.
  - d. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.
7. Blade Axles: Galvanized steel.
8. Bearings:
  - a. Molded synthetic.
  - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
9. Blade Seals: Neoprene.
10. Jamb Seals: Cambered aluminum.
11. Tie Bars and Brackets: Galvanized steel.
12. Accessories:
  - a. Include locking device to hold single-blade dampers in a fixed position without vibration.

E. Jackshaft:

1. Size: 0.5-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

F. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

## 2.6 CONTROL DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Warming and Ventilating; a Mestek Architectural Group company.
  2. Cesco Products; a division of MESTEK, Inc.
  3. Greenheck Fan Corporation.
  4. Lloyd Industries, Inc.
  5. McGill AirFlow LLC.
  6. Nailor Industries Inc.
  7. Pottorff.
  8. Ruskin Company.
  9. Vent Products Co., Inc.
- B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
- C. Frames:
1. Hat shaped.
  2. .094-inch-thick, galvanized sheet steel.
  3. Mitered and welded corners.
- D. Blades:
1. Multiple blade with maximum blade width of 6 inches.
  2. Parallel and opposed blade design.
  3. Galvanized-steel.
  4. 0.064 inch thick single skin.
  5. Blade Edging: Closed-cell neoprene.
  6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
- E. Blade Axles: 1/2-inch-diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
1. Operating Temperature Range: From minus 40 to plus 200 deg F.
- F. Bearings:
1. Molded synthetic.
  2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
  3. Thrust bearings at each end of every blade.

## 2.7 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Aire Technologies.
  2. American Warming and Ventilating; a Mestek Architectural Group company.
  3. Arrow United Industries.
  4. Cesco Products; a division of MESTEK, Inc.
  5. Greenheck Fan Corporation.

6. Nailor Industries Inc.
7. NCA Manufacturing, Inc.
8. Pottorff.
9. Prefco.
10. Ruskin Company.
11. Vent Products Co., Inc.
12. Ward Industries; a brand of Hart & Cooley, Inc.

- B. Type: Static; rated and labeled according to UL 555 by an NRTL.
- C. Closing rating in ducts up to 3-inch wg static pressure class and minimum 2000-fpm velocity.
- D. Fire Rating: 1-1/2 hours.
- E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
  1. Minimum Thickness: 0.05 thick, as indicated, and of length to suit application.
  2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed, interlocking, 0.024-inch thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
- I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.
- K. Heat-Responsive Device: replaceable link and switch package, factory installed, 165 deg F rated.

## 2.8 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Aire Technologies.
  2. American Warming and Ventilating; a Mestek Architectural Group company.
  3. Cesco Products; a division of MESTEK, Inc.
  4. Greenheck Fan Corporation.
  5. Nailor Industries Inc.
  6. Pottorff.
  7. Ruskin Company.
- B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.
- C. Closing rating in ducts up to 3-inch wg static pressure class and minimum 2000-fpm velocity.
- D. Fire Rating: 1-1/2 hours.

- E. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, with welded interlocking, corners and mounting flange.
- F. Heat-Responsive Device: Resettable, 165 deg F rated, fusible links fire-closure device.
- G. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.
- H. Smoke Detector: Integral, factory wired for single-point connection.
- I. Blades: Roll-formed, horizontal, interlocking, 0.063-inch thick, galvanized sheet steel.
- J. Leakage: Class I.
- K. Rated pressure and velocity to exceed design airflow conditions.
- L. Mounting Sleeve: Factory-installed, 0.039-inch thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.
- M. Master control panel for use in dynamic smoke-management systems.
- N. Damper Motors: two-position action.
- O. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
  - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
  - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
  - 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
  - 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
  - 5. Motors in Outdoor Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
  - 6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
  - 7. Electrical Connection: 115 V, single phase, 60 Hz.
- P. Accessories:
  - 1. Auxiliary switches for signaling fan control or position indication.
  - 2. Test and reset switches.

## 2.9 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. CL WARD & Family Inc.

2. Ductmate Industries, Inc.
3. Hardcast, Inc.
4. Nexus PDQ.
5. Ward Industries; a brand of Hart & Cooley, Inc.

B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

## 2.10 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aero-Dyne Sound Control Co.
2. CL WARD & Family Inc.
3. Ductmate Industries, Inc.
4. Duro Dyne Inc.
5. Elgen Manufacturing.
6. Hardcast, Inc.
7. METALAIRE, Inc.
8. SEMCO LLC.
9. Ward Industries; a brand of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

D. Vane Construction: Single or Double wall.

E. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

## 2.11 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aire Technologies.
2. American Warming and Ventilating; a Mestek Architectural Group company.
3. Cesco Products; a division of MESTEK, Inc.
4. CL WARD & Family Inc.
5. Ductmate Industries, Inc.
6. Elgen Manufacturing.
7. Flexmaster U.S.A., Inc.
8. Greenheck Fan Corporation.
9. McGill AirFlow LLC.

10. Nailor Industries Inc.
11. Pottorff.
12. Ventfabrics, Inc.
13. Ward Industries; a brand of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:
  - a. Double wall, rectangular.
  - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
  - c. Vision panel.
  - d. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
  - e. Fabricate doors airtight and suitable for duct pressure class.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
  - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
  - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
  - c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
  - d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:

1. Door and Frame Material: Galvanized sheet steel.
2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set at 3.0 to 8.0-inch wg.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch-thick, fibrous-glass or polystyrene-foam board.

## 2.12 DUCT ACCESS PANEL ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. 3M.
2. Ductmate Industries, Inc.
3. Flame Gard, Inc.

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.

- D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.
- E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
- F. Minimum Pressure Rating: 10-inch wg, positive or negative.

## 2.13 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. CL WARD & Family Inc.
  - 2. Ductmate Industries, Inc.
  - 3. Duro Dyne Inc.
  - 4. Elgen Manufacturing.
  - 5. Hardcast, Inc.
  - 6. JP Lamborn Co.
  - 7. Ventfabrics, Inc.
  - 8. Ward Industries; a brand of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
  - 1. Minimum Weight: 26 oz./sq. yd.
  - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
  - 3. Service Temperature: Minus 40 to plus 200 deg F.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
  - 1. Minimum Weight: 24 oz./sq. yd.
  - 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
  - 3. Service Temperature: Minus 50 to plus 250 deg F.
- G. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
  - 1. Minimum Weight: 16 oz./sq. yd.
  - 2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
  - 3. Service Temperature: Minus 67 to plus 500 deg F.
- H. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
  - 1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.

2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

## 2.14 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Flexmaster U.S.A., Inc.
  2. Flex-Tek Group.
  3. JP Lamborn Co.
  4. McGill AirFlow LLC.
  5. Ward Industries; a brand of Hart & Cooley, Inc.
  6. Temperature Range: Minus 20 to plus 210 deg F.
  
- B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
  1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
  2. Maximum Air Velocity: 4000 fpm.
  3. Temperature Range: Minus 10 to plus 160 deg F.
  4. Insulation R-value: 6.
  
- C. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
  1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
  2. Maximum Air Velocity: 4000 fpm.
  3. Temperature Range: Minus 20 to plus 175 deg F.
  4. Insulation R-Value: 6.
  
- D. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
  1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
  2. Maximum Air Velocity: 4000 fpm.
  3. Temperature Range: Minus 20 to plus 210 deg F.
  4. Insulation R-value: 6.
  
- E. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
  1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
  2. Maximum Air Velocity: 4000 fpm.
  3. Temperature Range: Minus 20 to plus 210 deg F.
  4. Insulation R-value: 6.



F. Insulated, Flexible Duct: UL 181, Class 0, interlocking spiral of aluminum foil; fibrous-glass insulation; polyethylene vapor-barrier film.

1. Pressure Rating: 8-inch wg positive or negative.
2. Maximum Air Velocity: 5000 fpm.
3. Temperature Range: Minus 20 to plus 250 deg F.
4. Insulation R-value: 6.

G. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.
2. Non-Clamp Connectors: Adhesive plus sheet metal screws.

## 2.15 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers according to UL listing.

H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.

2. Upstream and downstream from duct filters.
  3. At outdoor-air intakes and mixed-air plenums.
  4. At drain pans and seals.
  5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
  6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
  7. At each change in direction and at maximum 50-foot spacing.
  8. Upstream and downstream from turning vanes.
  9. Upstream or downstream from duct silencers.
  10. Control devices requiring inspection.
  11. Elsewhere as indicated.
- I. Install access doors with swing against duct static pressure.
- J. Access Door Sizes:
1. One-Hand or Inspection Access: 8 by 5 inches.
  2. Two-Hand Access: 12 by 6 inches.
  3. Head and Hand Access: 18 by 10 inches.
  4. Head and Shoulders Access: 21 by 14 inches.
  5. Body Access: 25 by 14 inches.
  6. Body plus Ladder Access: 25 by 17 inches.
- K. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- L. Install flexible connectors to connect ducts to equipment.
- M. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- N. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- O. Connect diffusers to ducts directly with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- P. Connect flexible ducts to metal ducts with draw bands plus sheet metal screws.
- Q. Install duct test holes where required for testing and balancing purposes.
- R. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.
- 3.2 FIELD QUALITY CONTROL
- A. Tests and Inspections:
1. Operate dampers to verify full range of movement.

2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION

## SECTION 23 3416

### CENTRIFUGAL HVAC FANS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section Includes:
  - 1. Forward-curved centrifugal fans.

##### 1.4 ACTION SUBMITTALS

- A. Product Data:
  - 1. Include rated capacities, furnished specialties, and accessories for each fan.
  - 2. Certified fan performance curves with system operating conditions indicated.
  - 3. Certified fan sound-power ratings.
  - 4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
  - 5. Material thickness and finishes, including color charts.
  - 6. Dampers, including housings, linkages, and operators.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.
  - 4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
  - 5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

##### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
- B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AMCA Compliance:

- 1. Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.
- 2. Operating Limits: Classify according to AMCA 99.

B. Unusual Service Conditions:

- 1. Ambient Temperature: 95 deg F.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Capacities and Characteristics:

- 1. Total Airflow: As scheduled.
- 2. External Static Pressure: As scheduled.
- 3. Class: I.
- 4. Arrangement: Per contract documents.
- 5. Housing Material: Reinforced steel.
- 6. Special Housing Coating: Powder-baked enamel.
- 7. Wheel Size (Diameter): As scheduled.
- 8. Wheel Material: Steel.
- 9. Special Wheel Coating: Hot dip galvanized.
- 10. Brake Horsepower: As scheduled.
- 11. Drive Type: Belt.
- 12. Fan Rpm: As scheduled.
- 13. Motor:
  - a. Motor Enclosure: Open, drip proof or Totally enclosed, fan cooled
  - b. Enclosure Materials: Cast iron, Cast aluminum or Rolled steel.
  - c. Motor Bearings: Ball.
  - d. Efficiency: Premium efficient.
  - e. Service Factor: 1.15.
  - f. Electrical Characteristics:
    - 1) Motor Size: As scheduled.
    - 2) Motor Rpm: As scheduled.
    - 3) Volts: As scheduled.
    - 4) Phase: As scheduled.
    - 5) Hertz: 60.

14. Vibration Isolators: Spring isolators having a static deflection of 1-inch deflection.

## 2.2 FORWARD-CURVED CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Greenheck.
2. Penn Barry.
3. Acme Engineering & Manufacturing Corp.
4. Loren Cook Co.

B. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

C. Housings:

1. Formed panels to make curved-scroll housings with shaped cutoff.
2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
3. Horizontally split, bolted-flange housing.
4. Spun inlet cone with flange.
5. Outlet flange.

D. Forward-Curved Wheels:

1. Black-enameled or galvanized-steel construction with inlet flange, backplate, shallow blades with inlet and tip curved forward in direction of airflow.
2. Mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.

E. Shafts:

1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

F. Prelubricated and Sealed Shaft Bearings:

1. Self-aligning, pillow-block-type ball bearings.
2. Ball-Bearing Rating Life: ABMA 9, L10 at 50,000 hours.
3. Roller-Bearing Rating Life: ABMA 11, L10 at 50,000 hours.

G. Grease-Lubricated Shaft Bearings:

1. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.

2. Ball-Bearing Rating Life: ABMA 9, L10 at 50,000 hours.

H. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: 1.5.
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 25 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

I. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
5. Discharge Dampers: Assembly with parallel blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
6. Inlet Screens: Grid screen of same material as housing.
7. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
8. Spark-Resistant Construction: AMCA 99.
9. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
10. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

## 2.3 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

## 2.4 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210/ASHRAE 51, "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating."

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install centrifugal fans level and plumb.
- B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.
- D. Equipment Mounting:
  - 1. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration Controls for HVAC."
- E. Curb Support: Install roof curb on roof structure, level and secure, according to "The NRCA Roofing and Waterproofing Manual," Low-Slope Membrane Roofing Construction Details Section, Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install and secure centrifugal fans on curbs, and coordinate roof penetrations and flashing with roof construction. Secure units to curb support with anchor bolts.
- F. Unit Support: Install centrifugal fans level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure units to structural support with anchor bolts.
- G. Isolation Curb Support: Install centrifugal fans on isolation curbs and install flexible duct connectors and vibration isolation.
  - 1. Comply with requirements in Section 233300 "Air Duct Accessories" for flexible duct connectors.
  - 2. Comply with requirements in Section 230548 "Vibration Controls for HVAC" for vibration isolation devices.
- H. Install units with clearances for service and maintenance.
- I. Label fans according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

### 3.2 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."
- B. Install ducts adjacent to fans to allow service and maintenance.
- C. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.

### 3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.



C. Perform the following tests and inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. See Section 230593 "Testing, Adjusting, and Balancing For HVAC" for testing, adjusting, and balancing procedures.
10. Remove and replace malfunctioning units and retest as specified above.

D. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION

## SECTION 233423

### HVAC POWER VENTILATORS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section Includes:
  - 1. Utility set fans.
  - 2. Centrifugal roof ventilators.
  - 3. In-line centrifugal fans.
  - 4. Propeller fans.

##### 1.4 PERFORMANCE REQUIREMENTS

- A. Operating Limits: Classify according to AMCA 99.

##### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
  - 1. Certified fan performance curves with system operating conditions indicated.
  - 2. Certified fan sound-power ratings.
  - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
  - 4. Material thickness and finishes, including color charts.
  - 5. Dampers, including housings, linkages, and operators.
  - 6. Roof curbs.
  - 7. Fan speed controllers.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Delegated-Design Submittal: For unit hangars and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
  1. Roof framing and support members relative to duct penetrations.
  2. Ceiling suspension assembly members.
  3. Size and location of initial access modules for acoustical tile.
  4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- B. Field quality-control reports.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

#### 1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Belts: **One** set for each belt-driven unit.

#### 1.9 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
- C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

#### 1.10 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided.
- C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

## PART 2 - PRODUCTS

### 2.1 UTILITY SET FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck Corporation
  2. Aerovent; a division of Twin City Fan Companies, Ltd.
  3. Breidert Air Products.
  4. Loren Cook Company.
  5. Peerless Blowers.
  6. Penn/Barry.
- B. Housing: Fabricated of **galvanized** steel with side sheets fastened with a deep lock seam or welded to scroll sheets.
1. Housing Discharge Arrangement: Adjustable to eight standard positions.
- C. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.
1. Blade Materials: Steel and Aluminum.
  2. Blade Type: Backward inclined, forward curved or Airfoil.
- D. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
- E. Shaft Bearings: Pre-lubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9, L<sub>50</sub> of 200,000 hours.
1. Extend grease fitting to accessible location outside of unit.
- F. Belt Drives:
1. Factory mounted, with final alignment and belt adjustment made after installation
  2. Service Factor Based on Fan Motor Size: 1.5
  3. Motor Pulleys: Adjustable pitch for use with motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
  4. Belts: Oil resistant, non-sparking, and non-static; matched sets for multiple belt drives.
  5. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
- G. Accessories:
1. Inlet and Outlet: Flanged.
  2. Companion Flanges: Rolled flanges for duct connections of same material as housing.
  3. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades with felt edges in steel frame installed on fan discharge.
  4. Access Door: Gasketed door in scroll with latch-type handles.
  5. Scroll Dampers: Single-blade damper installed at fan scroll top with adjustable linkage.
  6. Inlet Screens: Removable wire mesh.
  7. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.
  8. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.

9. Discharge Dampers: Assembly with parallel blades constructed of two plates formed around and to shaft, channel frame, sealed ball bearings, with blades linked outside of airstream to single control lever of same material as housing.
10. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
11. Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

H. Capacities and Characteristics:

1. Airflow: As scheduled.
2. External Static Pressure: As scheduled.
3. Wheel Type: Backward inclined.
4. Class: I.
5. Drive Arrangement: Belt.
6. Fan rpm: As scheduled.
7. Brake Horsepower: As scheduled.
8. Motor Size: As scheduled.
9. Electrical Characteristics:
  - a. Volts: As scheduled.
  - b. Phase: As scheduled.
  - c. Hertz: 60.

10. Vibration Isolators:
  - a. Type: Spring isolators.

11. Spark Arrestance Class: A.

## 2.2 CENTRIFUGAL ROOF VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Greenheck Fan Corporation.
  2. Acme Engineering & Manufacturing Corp.
  3. Aerovent; a division of Twin City Fan Companies, Ltd..
  4. Breidert Air Products.
  5. Loren Cook Company.
  6. PennBarry.
- B. Housing: Removable, spun-aluminum, dome top and outlet baffle, one-piece, aluminum base with venturi inlet cone.
  1. Up-blast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector.
  2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
- C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- D. Belt Drives:
  1. Resiliently mounted to housing.

2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
4. Pulleys: Cast-iron, adjustable-pitch motor pulley.
5. Fan and motor isolated from exhaust airstream.

E. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum, or brass wire.
3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
4. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Built-in raised cant and mounting flange.
2. Overall Height: 12 inches.
3. Metal Liner: Galvanized steel.
4. Vented Curb: Unlined with louvered vents in vertical sides.

G. Capacities and Characteristics:

1. Airflow: As scheduled.
2. External Static Pressure: As scheduled.
3. Drive Arrangement: Direct.
4. Fan rpm: As scheduled.
5. Damper: Yes.
6. Brake Horsepower: As scheduled
7. Motor Size: As scheduled.
8. Motor rpm: As scheduled.
9. Electrical Characteristics:
  - a. Volts: 277.
  - b. Phase: single.
  - c. Hertz: 60.

### 2.3 IN-LINE CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Greenheck Fan Corporation
2. Acme Engineering & Manufacturing Corp.
3. Breidert Air Products.
4. Loren Cook Company.
5. Peerless Blowers.
6. Penn/Barry.

B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

- C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door.
- D. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.
- E. Accessories:
  - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
  - 2. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
  - 3. Companion Flanges: For inlet and outlet duct connections.
  - 4. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
  - 5. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.
- F. Capacities and Characteristics:
  - 1. Airflow: As scheduled.
  - 2. External Static Pressure: As scheduled.
  - 3. Wheel Type: Forward curved.
  - 4. Class: I.
  - 5. Fan rpm: As scheduled.
  - 6. Brake Horsepower: As scheduled.
  - 7. Motor Size: As scheduled.
  - 8. Electrical Characteristics:
    - a. Volts: 277.
    - b. Phase: single.
    - c. Hertz: 60.
  - 9. Vibration Isolators:
    - a. Type: Elastomeric hangers.
  - 10. Spark Arrestance Class: A.

## 2.4 PROPELLER FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Greenheck Fan Corporation
  - 2. Acme Engineering & Manufacturing Corp.
  - 3. Aerovent; a division of Twin City Fan Companies, Ltd.
  - 4. Breidert Air Products.
  - 5. Loren Cook Company.
  - 6. Penn/Barry.
- B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.
- C. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.

- D. Fan Wheel: Replaceable, cast extruded-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.
- E. Fan Drive: Motor mounted in airstream; factory wired to disconnect switch located on outside of fan housing.
- F. Fan Drive:
  - 1. Resiliently mounted to housing.
  - 2. Statically and dynamically balanced.
  - 3. Selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
  - 4. Extend grease fitting to accessible location outside of unit.
  - 5. Service Factor Based on Fan Motor Size: 1.4.
  - 6. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
  - 7. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
    - a. Ball-Bearing Rating Life: ABMA 9,  $L_{10}$  of 100,000 hours.
  - 8. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
  - 9. Motor Pulleys: Adjustable pitch for use with motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
  - 10. Belts: Oil resistant, non-sparking, and non-static; matched sets for multiple belt drives.
  - 11. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
- G. Accessories:
  - 1. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.
  - 2. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
  - 3. Wall Sleeve: Galvanized steel to match fan and accessory size.
  - 4. Weather shield Front Guard: Galvanized steel with expanded metal screen.
  - 5. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
  - 6. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
- H. Capacities and Characteristics:
  - 1. Airflow: As scheduled.
  - 2. Fan rpm: As scheduled.
  - 3. Brake Horsepower: As scheduled.
  - 4. Motor Size: As scheduled.
  - 5. Electrical Characteristics:
    - a. Volts: 277.
    - b. Phase: single.
    - c. Hertz: 60.
  - 6. Vibration Isolators:
    - a. Type: Elastomeric hangers.
  - 7. Spark Arrestance Class: A.



## 2.5 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
  - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- B. Enclosure Type: Totally enclosed, fan cooled.

## 2.6 SOURCE QUALITY CONTROL

- A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Equipment Mounting:
- C. Secure roof-mounted fans to roof curbs with cadmium-plated hardware.
- D. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- E. Support suspended units from structure using threaded steel rods and elastomeric hangers having a static deflection of 1 inch. Vibration-control devices are specified in Section 230548 "Vibration Control for HVAC."
- F. Install units with clearances for service and maintenance.
- G. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

### 3.2 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to the electrical division of the specifications.
- D. Connect wiring according to the electrical division of the specifications.

### 3.3 FIELD QUALITY CONTROL

#### A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

#### B. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

#### C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

#### D. Prepare test and inspection reports.

### 3.4 ADJUSTING

#### A. Adjust damper linkages for proper damper operation.

#### B. Adjust belt tension.

#### C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

#### D. Replace fan and motor pulleys as required to achieve design airflow.

#### E. Lubricate bearings.

END OF SECTION

SECTION 233600

AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

- A. Section Includes:
  - 1. Shutoff, single-duct air terminal units.
  - 2. Parallel, fan-powered air terminal units.
  - 3. Series, fan-powered air terminal units.
  - 4. Casing liner.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of air terminal unit.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. LEED Submittals:
  - 1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
  - 2. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
- C. Shop Drawings: For air terminal units.
  - 1. Include plans, elevations, sections, and mounting details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.
  - 4. Hangers and supports, including methods for duct and building attachment and vibration isolation.
- D. Delegated-Design Submittal:

1. Materials, fabrication, assembly, and spacing of hangers and supports.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  1. Ceiling suspension assembly members.
  2. Size and location of initial access modules for acoustic tile.
  3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- B. Field quality-control reports.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.
  1. In addition to items specified in "Operation and Maintenance Data," include the following:
    - a. Instructions for resetting minimum and maximum air volumes.
    - b. Instructions for adjusting software set points.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Fan-Powered-Unit Filters: Furnish one spare filter for each filter installed.

### PART 2 - PRODUCTS

#### 2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- C. ASHRAE Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."

#### 2.2 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Titus.
  2. Carnes Company.
  3. Krueger.
  4. METALAIRE, Inc.
  5. Nailor Industries Inc.
  6. Price Industries.

7. Trane.
  8. Tuttle & Bailey.
- B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- C. Casing: 0.040-inch thick galvanized steel, single wall.
1. Casing Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric duct liner.
  2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
  3. Air Outlet: S-slip and drive connections, size matching inlet size.
  4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
  5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at temperatures from zero to 140 deg F, shall be impervious to moisture and fungus, shall be suitable for 10-inch wg static pressure, and shall be factory tested for leaks.
- E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
  2. Damper Position: Normally open.
- F. Electric Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.
1. Location: Discharge air.
  2. Stage: 1.
  3. Access door interlocked disconnect switch.
  4. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
  5. Nickel chrome 80/20 heating elements.
  6. Airflow switch for proof of airflow.
  7. Fan interlock contacts.
  8. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
  9. Mercury contactors.
  10. Pneumatic-electric switches and relays.
  11. Magnetic contactor for each step of control (for three-phase coils).
- G. Factory-Mounted and Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.
1. Control Transformer: Provide stepdown transformer for control voltage. Refer to drawings for source power characteristics. Where multiple VAV shut-off terminals are located within proximity, a centralized transformer shall be located strategically to feed multiple VAVs. Coordinate the transformer locations with the electrical contractor and as required for access with the ceiling finishes.

2. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
  3. Disconnect Switch: Factory-mounted, fuse type.
- H. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.
- I. Control devices shall be compatible with temperature controls system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
1. Electronic Damper Actuator: 24 V, powered open, spring return.
  2. Terminal Unit Controller: Pressure-independent, variable-air-volume (VAV) controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
    - a. Occupied and unoccupied operating mode.
    - b. Remote reset of airflow or temperature set points.
    - c. Adjusting and monitoring with portable terminal.
    - d. Communication with temperature-control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
- J. Controls:
1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg inlet static pressure.
- K. Control Sequences:
1. Occupied:
    - a. In a call for cooling, airflow will increase as the damper opens towards maximum setting to satisfy set point.
    - b. In a call for less cooling, airflow will decrease as the damper closes towards minimum setting to satisfy set point.
  2. Unoccupied:
    - a. Damper closes to minimum maximum setting.

### 2.3 PARALLEL FAN-POWERED AIR TERMINAL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Titus.
  2. Carnes Company.
  3. Krueger.
  4. METALAIRE, Inc.
  5. Nailor Industries Inc.
  6. Price Industries.
  7. Trane.
  8. Tuttle & Bailey.

- B. Configuration: Volume-damper assembly and fan in parallel arrangement inside unit casing with control components inside a protective metal shroud. Designed for quiet operation.
- C. Casing: 0.040-inch thick galvanized steel, single wall.
  - 1. Casing Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric duct liner.
  - 2. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
  - 3. Air Outlet: S-slip and drive connections.
  - 4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
  - 5. Fan: Forward-curved centrifugal, located at plenum air inlet.
  - 6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.
  - 1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
  - 2. Damper Position: Normally open.
- E. Velocity Sensors: Multipoint array with velocity sensors.
- F. Motor:
  - 1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
  - 2. Type: Electronically commutated motor.
  - 3. Fan-Motor Assembly Isolation: Rubber isolators.
  - 4. Enclosure: Open drip proof
  - 5. Enclosure Materials: Rolled steel.
  - 6. Efficiency: Premium efficient.
  - 7. Service Factor: 1.15
  - 8. Motor Speed: Multispeed.
    - a. Speed Control: Infinitely adjustable with electronic controls.
  - 9. Electrical Characteristics:
    - a. Horsepower: As scheduled.
    - b. Volts: As scheduled.
    - c. Phase: As scheduled.
    - d. Hertz: 60.
- G. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
  - 1. Material: Pleated cotton-polyester media having 90 percent arrestance and 8 MERV.
  - 2. Thickness: 1 inch.
- H. Electric Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and

secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.

1. Location: Plenum air inlet.
  2. SCR controlled.
  3. Access door interlocked disconnect switch.
  4. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
  5. Nickel chrome 80/20 heating elements.
  6. Airflow switch for proof of airflow.
  7. Fan interlock contacts.
  8. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
  9. Mercury contactors.
  10. Pneumatic-electric switches and relays.
  11. Magnetic contactor for each step of control (for three-phase coils).
- I. Factory-Mounted and Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.
1. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
  2. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
  3. Disconnect Switch: Factory-mounted, fuse type.
- J. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.
- K. Control devices shall be compatible with temperature controls system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
1. Electronic Damper Actuator: 24 V, powered open, spring return.
  2. Terminal Unit Controller: Pressure-independent, variable-air-volume (VAV) controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
    - a. Occupied and unoccupied operating mode.
    - b. Remote reset of airflow or temperature set points.
    - c. Adjusting and monitoring with portable terminal.
    - d. Communication with temperature-control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
- L. Controls:
1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg inlet static pressure.
- M. Control Sequence:
1. Occupied (Primary Airflow On):
    - a. Operate as throttling control for cooling.
    - b. As cooling requirement decreases, control valve throttles toward minimum airflow.



- c. As heating requirement increases, fan energizes to draw in warm plenum air and the hot-water coil valve is energized.
- 2. Unoccupied (Primary Airflow Off):
  - a. When pressure at primary inlet is zero or less, fan is de-energized.
  - b. As heating requirement increases, fan energizes to draw in warm plenum air and the hot-water coil valve will be energized.

## 2.4 SERIES FAN-POWERED AIR TERMINAL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Titus.
  - 2. Carnes.
  - 3. Krueger.
  - 4. METALAIRE, Inc.
  - 5. Nailor Industries Inc.
  - 6. Price Industries.
  - 7. Trane.
  - 8. Tuttle & Bailey.
- B. Configuration: Volume-damper assembly and fan in series arrangement inside unit casing with control components inside a protective metal shroud for installation above a ceiling.
  - 1. Designed for quiet operation.
  - 2. Low-profile design.
- C. Casing: 0.040-inch thick galvanized steel, single wall.
  - 1. Casing Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric duct liner.
  - 2. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
  - 3. Air Outlet: S-slip and drive connections.
  - 4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
  - 5. Fan: Forward-curved centrifugal.
  - 6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.
  - 1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
  - 2. Damper Position: Normally open.
- E. Velocity Sensors: Multipoint array with velocity sensors in air inlets and air outlets.
- F. Motor:
  - 1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

2. Type: Electronically commutated motor.
  3. Fan-Motor Assembly Isolation: Rubber isolators.
  4. Enclosure: Open drip proof
  5. Enclosure Materials: Rolled steel.
  6. Efficiency: Premium efficient.
  7. Service Factor: 1.15
  8. Motor Speed: Multispeed.
    - a. Speed Control: Infinitely adjustable with electronic controls.
  9. Electrical Characteristics:
    - a. Horsepower: As scheduled.
    - b. Volts: As scheduled.
    - c. Phase: As scheduled.
    - d. Hertz: 60.
- G. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
1. Material: Pleated cotton-polyester media having 90 percent arrestance and 8 MERV.
  2. Thickness: 1 inch.
- H. Electric Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.
1. Location: Plenum air inlet.
  2. SCR controlled.
  3. Access door interlocked disconnect switch.
  4. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
  5. Nickel chrome 80/20 heating elements.
  6. Airflow switch for proof of airflow.
  7. Fan interlock contacts.
  8. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
  9. Mercury contactors.
  10. Pneumatic-electric switches and relays.
  11. Magnetic contactor for each step of control (for three-phase coils).
- I. Factory Mounted and Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.
1. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
  2. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
  3. Disconnect Switch: Factory-mounted, fuse type.
- J. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

- K. Control devices shall be compatible with temperature controls system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
1. Electronic Damper Actuator: 24 V, powered open, spring return.
  2. Terminal Unit Controller: Pressure-independent, variable-air-volume (VAV) controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
    - a. Occupied and unoccupied operating mode.
    - b. Remote reset of airflow or temperature set points.
    - c. Adjusting and monitoring with portable terminal.
    - d. Communication with temperature-control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
- L. Controls:
1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg inlet static pressure.
- M. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.
- N. Control Sequence:
1. Occupied (Primary Airflow On):
    - a. Operate as throttling control for cooling.
    - b. As cooling requirement decreases, control valve throttles toward minimum airflow.
    - c. As heating requirement increases, fan energizes to draw in warm plenum air and the hot-water coil valve is opened.
  2. Unoccupied (Primary Airflow Off):
    - a. When externally initiated, begin the morning warm-up/cool-down function. Damper drives to the fully open position without regard for the preset maximum.
    - b. When pressure at primary inlet is zero or less, fan is de-energized.
    - c. As heating requirement increases, fan energizes to draw in warm plenum air and the hot-water coil valve is opened.

## 2.5 CASING LINER

- A. Casing Liner: Fibrous-glass duct liner, complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Minimum Thickness: 1 inch.
    - a. Maximum Thermal Conductivity:
      - 1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
      - 2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
  3. Solvent Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
    - a. Adhesive VOC Content: 80 g/L or less.
    - b. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Casing Liner: Flexible elastomeric duct liner fabricated of preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
1. Minimum Thickness: 3/4 inch.
  2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
  3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
    - a. Adhesive VOC Content: 50 g/L or less.
    - b. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

## 2.6 SOURCE QUALITY CONTROL

- A. Factory Tests: Test assembled air terminal units according to AHRI 880.
1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and AHRI certification seal.

## PART 3 - EXECUTION

### 3.1 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 5, "Hangers and Supports" and with Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
1. Where practical, install concrete inserts before placing concrete.
  2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
  4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
  5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hangers Exposed to View: Threaded rod and angle or channel supports.

- D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### 3.2 TERMINAL UNIT INSTALLATION

- A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
- C. Install wall-mounted thermostats.

### 3.3 CONNECTIONS

- A. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.
- B. Hot-Water Piping: Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties," and connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
- C. Comply with requirements in Section 233113 "Metal Ducts" for connecting ducts to air terminal units.
- D. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

### 3.4 IDENTIFICATION

- A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

### 3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections:
  - 1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
  - 2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Air terminal unit will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION

## SECTION 233713

### GRILLES, REGISTERS AND DIFFUSERS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Refer to drawing schedules for grille, register and diffuser types and accessories.
- B. Related Requirements:
  - 1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static pressure drop, and noise ratings.
  - 2. Grille and Diffuser Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Samples: For each exposed product and for each color and texture specified. Actual size of smallest diffuser indicated.
- C. Samples for Initial Selection: For diffusers with factory-applied color finishes. Actual size of smallest diffuser indicated.
- D. Samples for Verification: For diffusers, in manufacturer's standard sizes to verify color selected. Actual size of smallest diffuser indicated.

##### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Ceiling suspension assembly members.
  - 2. Method of attaching hangers to building structure.
  - 3. Size and location of initial access modules for acoustical tile.
  - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

5. Duct access panels.

B. Source quality-control reports.

## PART 2 - PRODUCTS

### 2.1 GRILLES REGISTERS AND DIFFUSERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Titus
2. Krueger.
3. Nailor Industries Inc.
4. Price Industries.
5. Tuttle & Bailey.

### 2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine areas where diffusers are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

A. Install grilles, registers and diffusers level and plumb.

B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install grilles, registers and diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire/smoke dampers.

### 3.3 ADJUSTING

A. After installation, adjust grilles, registers and diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION



## SECTION 233723

### HVAC GRAVITY VENTILATORS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section Includes:
  - 1. Louvered-penthouse ventilators.
  - 2. Roof hoods.

##### 1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design ventilators, including comprehensive engineering analysis by a qualified professional engineer, using structural performance requirements and design criteria indicated.
- B. Structural Performance: Ventilators shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of ventilator components, noise or metal fatigue caused by ventilator blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.
  - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- D. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.

##### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For gravity ventilators. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.
  - 1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

- C. Samples: For each exposed product and for each color and texture specified.
- D. Samples for Initial Selection: For units with factory-applied color finishes.
- E. Samples for Verification: For each type of louvered-penthouse ventilator indicated, in manufacturer's standard size.
- F. Delegated-Design Submittal: For shop-fabricated ventilators indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Detail fabrication and assembly of shop-fabricated ventilators.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof framing plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
  - 1. Structural members to which roof curbs and ventilators will be attached.
  - 2. Sizes and locations of roof openings.
- B. Seismic Qualification Certificates: For ventilators, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Welding certificates.

#### 1.7 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
  - 2. AWS D1.3, "Structural Welding Code - Sheet Steel."

#### 1.8 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Aluminium Extrusions : ASTM B 221, Alloy 6063-T5 or T-52.
- B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.

- C. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.
  - 1. Use types and sizes to suit unit installation conditions.
- D. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors made from stainless-steel components, with capability to sustain without failure a load equal to 4 times the loads imposed for concrete, or 6 times the load imposed for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

## 2.2 FABRICATION, GENERAL

- A. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.
- B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.
- D. Fabricate supports, anchorages, and accessories required for complete assembly.
- E. Perform shop welding by AWS-certified procedures and personnel.

## 2.3 LOUVERED-PENTHOUSE VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Greenheck Fan Corporation.
  - 2. Acme Engineering & Manufacturing Corp.
  - 3. Loren Cook Company.
  - 4. PennBarry.
- B. Construction: All-welded assembly with louvers, mitered corners, and **aluminum** sheet roof.
- C. Frame and Blade Material and Nominal Thickness: Extruded aluminum, of thickness required to comply with structural performance requirements, but not less than 0.080 inch for frames and 0.080 inch for blades.
  - 1. AMCA Seal: Mark units with the AMCA Certified Ratings Seal.
  - 2. Exterior Corners: Prefabricated corner units with mitered and welded blades and with fully recessed mullions at corners.
- D. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch-thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.
  - 1. Configuration: Built-in raised cant and mounting flange.
  - 2. Overall Height: 18 inches.

- E. Bird Screening: Aluminum, 1/2-inch-square mesh, 0.063-inch wire.
- F. Galvanized-Steel Sheet Finish:
  - 1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.
  - 2. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.
  - 3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat and an overall minimum dry film thickness of 2 mils.
    - a. Color and Gloss: As selected by Architect from manufacturer's full range.
- G. Accessories:
  - 1. Dampers:
    - a. Location: Inside louver face.
    - b. Control: Manual and/or Motorized.
- H. Capacities and Characteristics:
  - 1. Height: Refer to drawings.
  - 2. Width and Depth: Refer to drawings.
  - 3. Free Area: Refer to drawings.
  - 4. Air Performance: Refer to drawings.

## 2.4 ROOF HOODS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Greenheck Fan Corporation.
  - 2. Acme Engineering & Manufacturing Corp.
  - 3. Loren Cook Company.
  - 4. Penn/Barry.
- B. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figures 6-6 and 6-7.
- C. Materials: Galvanized-steel sheet, minimum 0.064-inch-thick base and 0.040-inch-thick hood; suitably reinforced.
- D. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch-thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.
  - 1. Configuration: Built-in raised cant and mounting flange.
  - 2. Overall Height: 18 inches.
- E. Bird Screening: Aluminum, 1/2-inch-square mesh, 0.063-inch wire.

F. Galvanized-Steel Sheet Finish:

1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.
2. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.
3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat and an overall minimum dry film thickness of 2 mils.
  - a. Color and Gloss: As selected by Architect from manufacturer's full range.

G. Capacities and Characteristics:

1. Height: Refer to drawings.
2. Width and Depth: Refer to drawings.
3. Free Area: Refer to drawings.
4. Air Performance: Refer to drawings.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.
- B. Install gravity ventilators with clearances for service and maintenance.
- C. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- D. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with the architectural sections of the specifications.
- E. Label gravity ventilators according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."
- F. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
- G. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

#### 3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in Section 233113 "Metal Ducts". Drawings indicate general arrangement of ducts and duct accessories.

3.3 ADJUSTING

- A. Adjust damper linkages for proper damper operation.

END OF SECTION

## SECTION 235113.16

### VENT DAMPERS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section Includes:

- 1. Barometric dampers.

- B. Related Requirements:

- 1. Section 235123 "Gas Vents" for listed special gas vents.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Shop Drawings: For each type of product.

- 1. Include plans, elevations, sections, and attachment details.
- 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- 3. Detail fabrication and assembly of hangers.

##### 1.5 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.

##### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For draft control devices to include in operation, and maintenance manuals.

##### 1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of barometric dampers that fail in materials or workmanship within specified warranty period.

- 1. Failure includes failure due to corrosion.

2. Warranty Period: Two years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 BAROMETRIC DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Effikal International Inc.
  2. ENERVEX Inc.
  3. FAMCO.
  4. Field Controls L.L.C.
  5. Quickdraft.
  6. Snappy Air Distribution Products.
  7. Tec-Air Inc.
  8. Tjernlund Products, Inc.
- B. Damper Construction: High-temperature-enamel-painted steel damper and housing with galvanized-steel breeching connection. Adjustable counterweight with lock. Include knife-edge bearings that do not require lubrication.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install listed components in a manner complying with the listing.
- B. Locate barometric dampers as close to draft hood collar as possible.
- C. Secure barometric dampers to breechings with hardware compatible with connected materials.

END OF SECTION



## SECTION 235123

### GAS VENTS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

###### A. Section Includes:

- 1. Listed double-wall vents.

###### B. Related Requirements:

- 1. Section 235113.16 "Vent Dampers" for barometric dampers.

##### 1.4 ACTION SUBMITTALS

###### A. Product Data: For each type of product.

- 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for product.

###### B. Shop Drawings: For vents.

- 1. Include plans, elevations, sections, and attachment details.
- 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- 3. Detail fabrication and assembly of hangers and seismic restraints.

##### 1.5 INFORMATIONAL SUBMITTALS

###### A. Welding certificates.

###### B. Sample Warranty: For special warranty.

##### 1.6 QUALITY ASSURANCE

###### A. Welding Qualifications: Qualify procedures and personnel according to the following:

- 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.

2. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in vents.

B. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

## PART 2 - PRODUCTS

### 2.1 LISTED SPECIAL GAS VENTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Heat-Fab, Inc.
2. Metal-Fab, Inc.
3. Selkirk Corporation.

B. Description: Double-wall metal vents tested according to UL 1738 and rated for 480 deg F continuously, with positive or negative flue pressure complying with NFPA 211.

C. Construction: Inner shell and outer jacket separated by at least a 1/2-inch airspace.

D. Inner Shell: ASTM A 959, Type 29-4C stainless steel.

E. Outer Jacket: Aluminized Stainless steel.

F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Termination: Round chimney top designed to exclude minimum 98 percent of rainfall.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 APPLICATION

A. Listed Special Gas Vent: Condensing gas appliances.

### 3.3 INSTALLATION OF LISTED VENTS

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in the architectural section of the specifications.

B. Comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.

C. Seal between sections of positive-pressure vents according to manufacturer's written installation instructions, using sealants recommended by manufacturer.

D. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.

E. Lap joints in direction of flow.

#### 3.4 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

END OF SECTION

## SECTION 237413

### VARIABLE AIR VOLUME PACKAGED ROOFTOP UNITS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:
  - 1. Supply air fan
  - 2. Direct-expansion cooling.
  - 3. Gas heating furnace.
  - 4. Heat recovery wheel.
  - 5. Hot gas reheat coil.
  - 6. Economizer outdoor- return- and relief air damper section.
  - 7. Return/relief air fan
  - 8. Packaged controls

##### 1.4 DEFINITIONS

- A. DDC: Direct-digital controls.
- B. ECM: Electrically commutated motor.
- C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
- F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating

operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

H. VAV: Variable-air volume.

#### 1.5 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Delegated-Design Submittal: For RTU supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.

2. Detail mounting, securing, and flashing of unit to existing curb. Indicate coordinating requirements with roof membrane system.

#### 1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which RTUs will be attached.

2. Roof openings

3. Roof curbs and flashing.

B. Field quality-control test reports.

C. Warranty: Special warranty specified in this Section.

#### 1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

#### 1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: One set for each belt-driven fan.

2. Filters: Two set of filters for each unit.

#### 1.9 QUALITY ASSURANCE

A. ARI Compliance:

1. Comply with ARI 203/110 and ARI 303/110 for testing and rating energy efficiencies for RTUs.
  2. Comply with ARI 270 for testing and rating sound performance for RTUs.
- B. ASHRAE Compliance:
1. Comply with ASHRAE 15 for refrigeration system safety.
  2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
  3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
- E. UL Compliance: Comply with UL 1995.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

#### 1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.
1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
  2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than five years from date of Substantial Completion.
  3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.
  4. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Aeon. (Basis of Design)
  2. Carrier Corporation; a unit of United Technologies Corp.
  3. Trane.
- B. When providing equipment from manufacturer other than basis of design, contractor is responsible for providing all modifications to existing curb, curb adaptors, modifications to existing supply and return ductwork being connected to and all other modifications necessary to accommodate equipment other than the basis of design.

## 2.2 CASING

- A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Exterior Casing Material: 18-gage Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
- C. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
  - 1. Materials: ASTM C 1071, Type I.
  - 2. Thickness: 3/4 inch.
  - 3. Density: 2.0 lbs; R-13.
  - 4. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
  - 5. Liner Adhesive: Comply with ASTM C 916, Type I.
- D. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

## 2.3 FANS

- A. Fan Drives:
  - 1. Unit shall be equipped with variable frequency drive (VFD) inverter. The VFD shall be installed inside the unit cabinet and shall be factory-mounted, wired and tested. The VFD shall control motor speed to maintain set point static pressure at the sensor tube location of the supply duct pressure transducer (transducer is factory-provided and installed; sensor tube must be field-routed). The control system may be field adjusted to maintain supply duct static pressure set points. The variable frequency drive shall include the following features:
    - a. Full digital control with direct control from the unit controls.
    - b. Insulated Gate Bi-Polar Transistors (IGBT) used to produce the output pulse width modulated (PWM) waveform, allowing for quiet motor operation.
    - c. Inverters capable of operation at a frequency of 8 kHz, so no acoustic noise shall be produced by the motor.
    - d. Self-diagnostics.
    - e. Personal lockout code for additional security.
    - f. Critical frequency avoidance.
    - g. RS485 capability standard.
    - h. Electronic thermal overload protection.
    - i. 5% swinging chokes for harmonic reduction and improved power factor.
    - j. All printed circuit boards shall be conformal coated.
- B. Indoor Supply Fans:
  - 1. Direct drive, unhooded, backward curved, plenum supply fans.
  - 2. Fan shaft bearings shall be of the pillow block type with positive locking collar and lubrication provisions.
  - 3. Statically and dynamically balanced.
  - 4. Fan shaft bearings shall have a life of 200,000 hours at design operating conditions in accordance with ANSI B3.15.

5. Solid fan shaft construction for nominal 40-ton units and two-piece solid fan shaft construction on the nominal unit 60-ton unit.

C. Condenser-Coil Fan:

1. Fans shall be direct-driven propeller type only, with corrosion-resistant blades riveted to corrosion resistant steel supports for all nominal 40-ton size units. Nominal 60-ton size units with the microchannel condenser coil shall have a direct driven, 9-blade airfoil cross section, reinforced polymer construction, and shrouded-axial type fans with inherent corrosion resistance.
2. Discharge air vertically upward and protected by PVC coated steel wire safety guards.
3. Statically and dynamically balanced.

D. Modulating Power Exhaust Fan: Belt driven, unhooded, backward curved, plenum type.

## 2.4 COILS

A. Supply-Air Refrigerant Coil:

1. Aluminum plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
3. Coil Split: Interlaced.
4. Condensate Drain Pan: Stainless steel formed with pitch and drain connections complying with ASHRAE 62.1.

B. Gas-Fired Furnace Heating:

- a. Heat-Transfer Rate: As scheduled.
- b. Entering-Air Temperature: As scheduled.
- c. Leaving-Air Temperature: As scheduled.
- d. Efficiency: 80 percent.
- e. Fuel: Natural gas.
- f. Gas Heating Value: As scheduled.
- g. Gas Input: As scheduled.
- h. Gas Burner Electrical Characteristics:
  - 1) Power Input: As scheduled.
  - 2) Volts: 460.
  - 3) Phase: Three.
  - 4) Hertz: 60.
  - 5) Full-Load Amperes: As scheduled.
  - 6) Minimum Circuit Ampacity: As scheduled.
  - 7) Maximum Overcurrent Protection: As scheduled.

## 2.5 REFRIGERANT CIRCUIT COMPONENTS

A. Number of Refrigerant Circuits: Two.

B. Compressors: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.

C. Variable Capacity Compressor: Hermetic, digital scroll on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief and crankcase heater.



D. Refrigeration Specialties:

1. Refrigerant: R-410A
2. Expansion valve with replaceable thermostatic element.
3. Solid core refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.

2.6 INDIRECT FIRED GAS FURNACE HEATING

A. Furnace Assembly:

1. Factory assembled, piped, and wired.
2. Comply with requirements in NFPA 54, "National Fuel Gas Code"; ANSI Z83.4, "Non-Recirculating Direct Gas-Fired Industrial Air Heaters"; and ANSI Z83.18, "Recirculating Direct Gas-Fired Industrial Air Heaters."

B. Burners:

1. Cast-iron burner with stainless-steel mixing plates.
2. Rated for a maximum turndown ratio of 30:1.
3. Fuel: Natural gas.

C. Safety Controls:

1. Gas manifold safety switches and controls shall comply with ANSI standards IRI.
2. Pilot: Intermittent spark igniter.
3. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.
4. External gas-pressure regulator shall regulate pressure to not more than 0.5 psig.
5. Airflow Proving Switch: Dual pressure switch senses correct airflow before energizing pilot and requires airflow to be maintained within minimum and maximum pressure settings across burner.
6. Manual-Reset, High-Limit Switch: Stops burner and closes main gas valve if high-limit temperature is exceeded.
7. Gas Train: Redundant main gas valves, electric pilot valve, main and pilot gas-pressure regulators, main and pilot manual shutoff valves, high-low gas-pressure switches, and main and pilot pressure taps, to comply with IRI requirements.

2.7 HEAT WHEELS

A. Casing:

1. Steel with standard factory-painted finish.
2. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg differential pressure.
3. Casing seals on periphery of rotor and on duct divider and purge section.
4. Support vertical rotors on grease-lubricated ball bearings having extended grease fittings or permanently lubricated bearings. Support horizontal rotors on tapered roller bearing.

B. Rotor: Glass-fiber or Polymer segmented wheel strengthened with radial spokes impregnated with nonmigrating, water-selective, 3A molecular-sieve desiccant coating.

1. Maximum Solid Size for Media to Pass: 800 micrometer.
- C. Drive: Fractional horsepower motor and gear reducer, with speed changed by variable frequency controller and self-adjusting multilink belt around outside of rotor.
1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
  2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

## 2.8 AIR FILTRATION

- A. Extended-Surface, Disposable Panel Pre-Filters and Filters:
1. Comply with NFPA 90A.
  2. Factory-fabricated, dry, extended-surface type.
  3. Thickness: 2 inches.
  4. Minimum Arrestance: 90, according to ASHRAE 52.1.
  5. Minimum MERV: 8, according to ASHRAE 52.2.
  6. Thickness: 4 inches.
  7. Minimum Arrestance: 90, according to ASHRAE 52.1.
  8. Minimum MERV: 13, according to ASHRAE 52.2.
  9. Media: Fibrous material formed into deep-V-shaped pleats with antimicrobial agent and held by self-supporting wire grid.
- B. Mounting Frames:
1. Extended surface filters arranged for flat orientation, removable from access plenum.
  2. Galvanized or stainless steel with gaskets and fasteners, suitable for bolting together into built-up filter banks with space for prefilter.

## 2.9 DAMPERS

- A. Outdoor-Air Damper: Linked damper blades, for 0 to 100 percent outdoor air, with motorized damper filter.
- B. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
1. Damper Motor: Modulating with adjustable minimum position.
  2. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IESNA 90.1, with bird screen and hood.
- C. Ultra-Low Leak Economizer:
1. Differential enthalpy controlled integrated type consisting of dampers, actuator, and linkages in conjunction with control system to provide primary cooling using outdoor air, conditions permitting, supplemented with mechanical cooling when necessary.
  2. a. Economizer shall meet the requirements of the California Energy Commission Title 24 economizer requirements.
  3. b. Dampers shall be a gear driven ultra-low leakage type with blade and edge seals. Dampers shall exhibit a maximum leakage rate of 3 cfm per square foot of area at 1 in.

wg pressure differential when tested in accordance with AMCA (Air Movement and Control Association) Standard 500.

4. Airflow Measurement:
  - a. Monitoring System: Complete and functioning system of airflow monitoring as an integral part of the damper assembly where indicated.
  - b. Remote Monitoring Signal: 0-10 volt or 4-20 mA scaled signal.
  - c. Accuracy of flow measurement: Within 10 percent of the actual flow rate between the range of the scheduled minimum and maximum airflow. For units with a large range between minimum and maximum airflow, configure the damper sections and flow measurement assembly as necessary to comply with accuracy.
  - d. Straightening Device: Integral to the flow measurement assembly if required to achieve the specified accuracy as installed.
  - e. flow measuring device: Suitable for operation in untreated and unfiltered outdoor air. If necessary, include temperature and altitude compensation and correction to maintain the accuracy.

## 2.10 ELECTRICAL POWER CONNECTION

- A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

## 2.11 CONTROLS

- A. Provide with manufacturer's packaged controller capable of sequencing all unit operations. Controller shall communicate with building's BacNet control system. Coordinate protocol and provide communications interface accordingly.
- B. Interface Requirements for HVAC Instrumentation and Control System:
  1. Interface relay for scheduled operation.
  2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
  3. Provide building management system compatible interface for central HVAC control workstation for the following:
    - a. Adjusting set points.
    - b. Monitoring supply fan start, stop, and operation.
    - c. Modulate supply and power exhaust fans.
    - d. Inquiring data to include outdoor-air damper position, supply- and room-air temperature and humidity.
    - e. Monitoring occupied and unoccupied operations.
    - f. Monitoring constant and variable motor loads.
    - g. Monitoring variable-frequency drive operation.
    - h. Monitoring cooling load.
    - i. Monitoring economizer cycles.
    - j. Monitoring air-distribution static pressure and ventilation air volume.
- C. Furnace Controls:
  1. Factory-mounted sensor in supply outlet with sensor adjustment located in control panel to modulate gas furnace burner to maintain space temperature.
  2. Electromechanical or Electronic Burner Control: 20 to 100 percent modulation of the firing rate.

## 2.12 ACCESSORIES

- A. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
- B. Coil guards of painted, galvanized-steel wire.
- C. Hail guards of galvanized steel.
- D. U.V Lights at cooling coils
- E. Vibration isolation rails.
- F. Building pressure sensors (2 per unit).
- G. Non-fused disconnect switch.
- H. Roof Curb: Full-perimeter plenum curb of sheet metal, minimum 24 inches high, with wood nailer, neoprene sealing strip, and welded Z-bar flashing.
  - 1. Comply with requirements in "The NRCA Roofing Manual."

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of duct connections before equipment installation.
- C. Examine roofs for suitable conditions where RTUs will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Roof Curb: Provide and install vibration isolation rails, set on plenum roof curb, level and secure. Secure RTUs to upper curb rail, and secure curb base to roof framing.
- B. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.
- C. Comply with requirements for gas-fired furnace installation in NFPA 54, "National Fuel Gas Code."

### 3.3 CONNECTIONS

- A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
- B. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
4. Install return-air duct continuously through roof structure.

C. Gas Piping Connections:

1. Comply with requirements in Section 231123 "Facility Natural-Gas Piping."
2. Connect gas piping to furnace, full size of gas train inlet, and connect with union, pressure regulator, and shutoff valve with sufficient clearance for burner removal and service.
3. Install AGA-approved flexible connectors.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Report results in writing.

C. Tests and Inspections:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to furnace combustion chamber.
3. Inspect for visible damage to compressor, coils, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean condenser coil and inspect for construction debris.

10. Clean furnace flue and inspect for construction debris.
11. Connect and purge gas line.
12. Remove packing from vibration isolators.
13. Inspect operation of barometric relief dampers.
14. Verify lubrication on fan and motor bearings.
15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
16. Adjust fan belts to proper alignment and tension.
17. Start unit according to manufacturer's written instructions.
  - a. Start refrigeration system.
  - b. Do not operate below recommended low-ambient temperature.
  - c. Complete startup sheets and attach copy with Contractor's startup report.
18. Inspect and record performance of interlocks and protective devices; verify sequences.
19. Operate unit for an initial period as recommended or required by manufacturer.
20. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
  - a. Measure gas pressure on manifold.
  - b. Inspect operation of power vents.
  - c. Measure combustion-air temperature at inlet to combustion chamber.
  - d. Measure flue-gas temperature at furnace discharge.
  - e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
  - f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
21. Calibrate thermostats.
22. Adjust and inspect high-temperature limits.
23. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
24. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
  - a. Coil leaving-air, dry- and wet-bulb temperatures.
  - b. Coil entering-air, dry- and wet-bulb temperatures.
  - c. Outdoor-air, dry-bulb temperature.
  - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
25. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
26. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
  - a. Supply-air volume.
  - b. Return-air volume.
  - c. Relief-air volume.
  - d. Outdoor-air intake volume.
27. Simulate maximum cooling demand and inspect the following:
  - a. Compressor refrigerant suction and hot-gas pressures.
  - b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.

28. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
  - a. High-temperature limit on gas-fired heat exchanger.
  - b. Low-temperature safety operation.
  - c. Filter high-pressure differential alarm.
  - d. Economizer to minimum outdoor-air changeover.
  - e. Relief-air fan operation.
  - f. Smoke and firestat alarms.
29. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

### 3.6 CLEANING AND ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to 4 visits to site during other-than-normal occupancy hours for this purpose.
- B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

### 3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs.

END OF SECTION

## SECTION 238123.13

### COMPUTER-ROOM AIR-CONDITIONERS, CEILING-MOUNTED UNITS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.2 SUMMARY

- A. Section includes ceiling-mounted, computer-room air conditioners.

##### 1.3 DEFINITIONS

- A. COP: Coefficient of performance.
- B. EER: Energy efficiency ratio.
- C. SCR: Silicon-controlled rectifier.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include material descriptions, dimensions of individual components and profiles, and finishes for computer-room air-conditioning units.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. LEED Submittals:
  - 1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.
  - 2. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
- C. Shop Drawings: For computer-room air conditioners.
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.
- D. Color Samples: For unit cabinet, discharge grille, and exterior louver and for each color and texture specified.



## 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, using input from installers of the items involved.
- B. Seismic Qualification Certificates: For computer-room air conditioners, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.
- D. Sample Warranty: For special warranty.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For computer-room air conditioners to include in emergency, operation, and maintenance manuals.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Filters: One set of filters for each unit.

## 1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of computer-room air conditioners that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
  - 2. Warranty Period for Humidifiers: Manufacturer's standard, but not less than three years from date of Substantial Completion.
  - 3. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Vertiv Liebert.
  - 2. Compu-Aire, Inc.
  - 3. Data Aire Inc.

## 2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Computer-room air-conditioners, ceiling-mounted units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. ASHRAE Compliance:
  - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
  - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."
- D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.
- E. ASME Compliance: Fabricate and label water-cooled condenser shell to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

## 2.3 MANUFACTURED UNITS

- A. Description: Self-contained, factory assembled, prewired, and pre-piped; consisting of cabinet, fan, filters, and controls.
  - 1. Mounting Configuration: Concealed above ceiling.
- B. Cabinet: Galvanized steel serviceable from one side, with baked-enamel finish, insulated with 1/2-inch-thick duct liner, and mounting bracket attached to the unit.
  - 1. Unit with supply and return collars for ducting in the field.
- C. Supply-Air Fan:
  - 1. Forward curved, double width, double inlet, centrifugal, with electronically commutated, and variable speed.
- D. Refrigeration System:
  - 1. Compressor: Scroll, with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.
  - 2. Refrigeration Circuit Components:
    - a. Low-pressure switch.
    - b. Manually reset, high-pressure switch.
    - c. Thermal-expansion valve with external equalizer.
    - d. Sight glass with moisture indicator.
    - e. Service shutoff valves.
    - f. Charging valves.
    - g. Hot-gas bypass.

- h. Refrigerant charge.
  - 3. Refrigerant: R-410A.
  - 4. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins.
  - 5. Refrigerant line-sweat-adapter kit to permit field brazing of refrigerant lines.
    - a. Mount stainless-steel drain pan having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir under coil assembly.
  - 6. Remote, Air-Cooled Refrigerant Condenser: Integral, copper-tube aluminum-fin coil with direct-drive, propeller fan.
  - 7. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.
- E. Electric-Resistance Reheat Coil:
- 1. Finned-tube electric elements with contactor.
  - 2. Dehumidification relay.
  - 3. High-temperature-limit switches.
  - 4. SCR to proportionally control the reheat elements providing precise temperature control.
- F. Filter: 1-inch-thick, disposable, glass-fiber media.
- 1. Arrestance: 90 percent, according to ASHRAE 52.2.
  - 2. MERV: 8 according to ASHRAE 52.2.
- G. Electrode Steam Humidifier: Self-contained, microprocessor-controlled unit with disposable, polypropylene-plastic cylinders, and having field-adjustable steel electrodes and stainless-steel steam dispersion tube.
- 1. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, pressure-reducing and flow-regulating orifice, and drain with integral air gap.
  - 2. Control: Fully modulating to provide gradual modulation from zero to 100 percent capacity with field-adjustable maximum capacity; with high-water probe.
  - 3. Drain Cycle: Field-adjustable drain duration and drain interval.
- H. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.
- I. Single point power kit permitting single electrical feed to the evaporator and condensing unit of a close-coupled system.
- J. Epoxy-coated, step-down transformer suitable for mounting on the outdoor condensing unit to provide it with 277-V input power.
- K. Control System:
- 1. Microprocessor unit mounted panel.
  - 2. Fan contactor.
  - 3. Compressor contactor.
  - 4. Compressor start capacitor.
  - 5. Control transformer with circuit breaker.
  - 6. Solid-state temperature and humidity control modules.

7. Humidity contactor.
8. Time-delay relay.
9. Heating contactor.
10. Smoke sensor.
11. Filter clog switch.
12. Alarm contacts.
13. High-temperature thermostat.
14. Solid-state, wall-mounted control panel with start-stop switch, adjustable humidity set point, remote temperature and humidity sensor and adjustable temperature set point.
15. Remote panel to monitor and change temperature and humidity set points and sensitivities of the unit and unit alarms.

L. Fan Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
  - a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load does not require motor to operate in service factor range above 1.0.
  - b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

## 2.4 CAPACITIES AND CHARACTERISTICS

- A. Refer to the schedule on the drawings for capacities and characteristics.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for hydronic piping systems to verify actual locations of piping connections before equipment installation.
- C. Examine walls, floors, and roofs for suitable conditions where computer-room air conditioners will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Layout and install computer-room air conditioners and suspension system coordinated with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
- B. Install computer-room air conditioners coordinated with computer-room access flooring Installer.
- C. Install computer-room air conditioners level and plumb, maintaining manufacturer's recommended clearances.
- D. Suspended Computer-Room Air Conditioners: Install using continuous-thread hanger rods and elastomeric hangers of size required to support weight of computer-room air conditioner.

1. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration Controls for HVAC." Fabricate brackets or supports as required.
  2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- E. Air-Cooled Refrigerant Condenser Mounting: Install using elastomeric pads on full size curbs. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration Controls for HVAC."
1. Minimum Deflection: 1/4 inch.

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other heating, ventilating, and air-conditioning Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to computer-room air conditioners, allow space for service and maintenance.
- C. Water and Drainage Connections: Comply with applicable requirements in Section 221116 "Domestic Water Piping." Provide adequate connections for water-cooled units, condensate drain, and humidifier flushing system.
- D. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Provide shutoff valves and piping.

### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
  2. After installing computer-room air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
  3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Computer-room air conditioners will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. After startup service and performance test, change filters and flush humidifier.

### 3.5 ADJUSTING

- A. Adjust initial temperature and humidity set points.

- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to one visit to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain computer-room air conditioners.

END OF SECTION

## SECTION 238239.13

### CABINET UNIT HEATERS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section includes cabinet unit heaters with centrifugal fans and electric-resistance heating coils.

##### 1.4 DEFINITIONS

- A. DDC: Direct digital control.
- B. PTFE: Polytetrafluoroethylene plastic.
- C. TFE: Tetrafluoroethylene plastic.

##### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include location and size of each field connection.
  - 4. Include details of anchorages and attachments to structure and to supported equipment.
  - 5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
  - 6. Indicate location and arrangement of piping valves and specialties.
  - 7. Indicate location and arrangement of integral controls.
  - 8. Wiring Diagrams: Power, signal, and control wiring.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.

- E. Samples for Verification: Finish colors for each type of cabinet unit heater indicated with factory-applied color finishes.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Suspended ceiling components.
  - 2. Structural members to which cabinet unit heaters will be attached.
  - 3. Method of attaching hangers to building structure.
  - 4. Size and location of initial access modules for acoustical tile.
  - 5. Items penetrating finished ceiling, including the following:
    - a. Lighting fixtures.
    - b. Air outlets and inlets.
    - c. Speakers.
    - d. Sprinklers.
    - e. Access panels.
  - 6. Perimeter moldings for exposed or partially exposed cabinets.
- B. Field quality-control reports.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

#### 1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Cabinet Unit-Heater Filters: Furnish **one** spare filter for each filter installed.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Berko; Marley Engineered Products.
  - 2. Chromalox, Inc.
  - 3. Markel Products; TPI Corporation.
  - 4. Marley Engineered Products.
  - 5. QMark; Marley Engineered Products.
  - 6. Trane.

#### 2.2 DESCRIPTION

- A. Factory-assembled and -tested unit complying with AHRI 440.



- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with UL 2021.

## 2.3 PERFORMANCE REQUIREMENTS

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

## 2.4 COIL SECTION INSULATION

- A. Insulation Materials: ASTM C 1071; surfaces exposed to airstream shall have erosion-resistant coating to prevent erosion of glass fibers.
  - 1. Thickness: 1/2 inch.
  - 2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F mean temperature.
  - 3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
  - 4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.
  - 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- B. Insulation Materials: Comply with NFPA 90A or NFPA 90B. Unicellular polyethylene thermal plastic, preformed sheet insulation complying with ASTM C 534, Type II, except for density.
  - 1. Thickness: 1 inch.
  - 2. Thermal Conductivity (k-Value): 0.24 Btu x in./h x sq. ft. at 75 deg F mean temperature.
  - 3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM C 411.
  - 4. Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
  - 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

## 2.5 CABINETS

- A. Material: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.
  - 1. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch thick galvanized sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
  - 2. operated.
  - 3. Base: Minimum 0.0528-inch-thick steel, finished to match cabinet, 4 inches high with leveling bolts.

## 2.6 FILTERS

- A. Minimum Arrestance: According to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Pleated: 90 percent arrestance, MERV 8.

## 2.7 COILS

- A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, mounted in ceramic inserts in galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

## 2.8 CONTROLS

- A. Fan and Motor Board: Removable.

1. Fan: Forward curved, double width, centrifugal, directly connected to motor; thermoplastic or painted-steel wheels and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

- B. Control devices and operational sequences are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

- C. Basic Unit Controls:

1. Control voltage transformer.
2. Unit mounted thermostat with the following features:
  - a. Heat-off switch.
  - b. Fan on-auto switch.
  - c. Manual fan-speed switch.
  - d. Adjustable deadband.
  - e. Concealed set point.
  - f. Concealed indication.
  - g. Deg F indication.
3. Unit mounted temperature sensor.
4. Unoccupied period override push button.
5. Data entry and access port.
  - a. Input data includes room temperature and occupied and unoccupied periods.
  - b. Output data includes room temperature, supply-air temperature, entering-water temperature, operating mode, and status.

- D. DDC Terminal Controller:

1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
2. Unit Supply-Air Fan Operations:
  - a. Occupied Periods: Fan runs continuously.
  - b. Unoccupied Periods: Fan cycles to maintain setback room temperature.

3. Heating-Coil Operations:
  - a. Occupied Periods: Energize electric-resistance coil to provide heating if room temperature falls below thermostat set point.
  - b. Unoccupied Periods: Start fan and energize electric-resistance coil if room temperature falls below setback temperature.
4. Controller shall have volatile-memory backup.

E. Interface with DDC System for HVAC Requirements:

1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at central workstation.
3. Interface shall be BAC-net compatible for central DDC system for HVAC workstation and include the following functions:
  - a. Adjust set points.
  - b. Cabinet unit-heater start, stop, and operating status.
  - c. Data inquiry, including supply-air and room-air temperature.
  - d. Occupied and unoccupied schedules.

F. Electrical Connection: Factory-wired motors and controls for a single field connection.

## 2.9 CAPACITIES AND CHARACTERISTICS

A. Cabinet:

1. Vertical, Surface Mounted: Upflow.
  - a. Top: Flat.
  - b. Air Inlet: Front, punched louver.
  - c. Air Outlet: Top punched louver.

B. Fan:

1. Airflow: As scheduled.
2. External Static Pressure: As scheduled.
3. Fan Speed: As scheduled.
4. Motor Horsepower: As scheduled.

C. Heating Capacity:

1. Output: As scheduled.
2. Entering-Air Temperature: As scheduled.
3. Air-Temperature Rise: As scheduled.

D. Electric-Resistance Heating Coil:

1. Capacity: As scheduled.
2. Number of Steps: As scheduled.

E. Filters:

1. Thickness: 1 inch.

F. Electrical Characteristics for Single-Point Connection:

1. Volts: 480.
2. Phase: 3.
3. Hertz: 60.
4. Full-Load Amperes: As scheduled.
5. Minimum Circuit Ampacity: As scheduled.
6. Maximum Overcurrent Protection: As scheduled.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall boxes in finished wall assembly, seal and weatherproof. Joint-sealant materials and applications as specified in the architectural division.
- B. Install cabinet unit heaters to comply with NFPA 90A.
- C. Install new filters in each unit within one week of Substantial Completion.

3.3 CONNECTIONS

- A. Ground equipment according to the electrical division of the specifications.
- B. Connect wiring according to the electrical division of the specifications.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
  3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- B. Units will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Adjust initial temperature set points.

- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to one visit to the project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters.

END OF SECTION

## SECTION 238239.19

### WALL AND CEILING UNIT HEATERS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.3 SUMMARY

- A. Section includes wall and ceiling heaters with propeller fans and electric-resistance heating coils.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include details of anchorages and attachments to structure and to supported equipment.
  - 4. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
  - 5. Wiring Diagrams: Power, signal, and control wiring.
- C. Samples: For each exposed product and for each color and texture specified.

##### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wall and ceiling unit heaters to include in emergency, operation, and maintenance manuals.

#### PART 2 - PRODUCTS

##### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Berko; Marley Engineered Products.

2. Chromalox, Inc.
3. INDEECO.
4. Markel Products; TPI Corporation.
5. Marley Engineered Products.
6. QMark; Marley Engineered Products.
7. Trane.

## 2.2 DESCRIPTION

- A. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.3 CABINET

- A. Front Panel: Stamped-steel louver with removable panels fastened with tamperproof fasteners.
- B. Finish: Baked enamel over baked-on primer with manufacturer's custom color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

## 2.4 COIL

- A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high-temperature protection. Provide integral circuit breaker for overcurrent protection.

## 2.5 FAN AND MOTOR

- A. Fan: Aluminum propeller directly connected to motor.
- B. Motor: Permanently lubricated, multispeed. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

## 2.6 CONTROLS

- A. Controls: Unit-mounted thermostat. Low-voltage relay with transformer kit.
- B. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

## 2.7 CAPACITIES AND CHARACTERISTICS

- A. Refer to drawing schedule for additional information.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas to receive wall and ceiling unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Install wall and ceiling unit heaters to comply with NFPA 90A.
- B. Install wall and ceiling unit heaters level and plumb.
- C. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with drawings and room details before installation.
- D. Ground equipment according to the electrical division of the specifications.
- E. Connect wiring according to the electrical division of the specifications.

END OF SECTION



## SECTION 260000

### GENERAL REQUIREMENTS FOR ELECTRICAL

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS:

- A. Division 01 Specifications, General and Supplemental Requirements apply to this section with additions and modifications specified herein.
- B. This Section shall apply to all Divisions 26, 27, and 28 Sections of these specifications as hereinafter written.
- C. Instructions to Bidders, Bidding Forms, Forms of Agreement between Owner and Contractor, Contract Award Date, Starting and Completion Dates, Conditions of the Contract, Insurance Requirements, and other Owner Requirements shall be furnished separately by the Owner, General Contractor or Construction Manager. These documents, as well as any addenda issued, shall form a part of these Specifications, and this Contractor shall consult them in detail for instructions pertaining to their work.
- D. Each contractor and sub-contractor shall be provided with all drawings and specification sections issued as part of the overall bid package, as well as all subsequent Addenda, Architects Supplemental Instructions (ASI), Bulletins or other project contract documents. All contractors and sub-contractors are to receive, review, and coordinate all of their work as shown or referenced on the other trade documents. All work shown or referenced on the other trade documents shall be included as part of the overall project scope. It is each contractor or sub-contractor's responsibility to confirm, prior to submitting their bid, that they have received all contract documents and supplemental information.

##### 1.3 SCOPE OF WORK:

- A. These specifications, accompanying drawings and all other contract documents are intended to cover the furnishing of all labor, material, equipment and superintendence of the Electrical System for this project. They are also intended to cover performing all miscellaneous operations including excavations and backfilling, cutting, channeling, chasing and patching necessary for the installation of the Electrical systems, as shown on the drawings, as hereinafter specified, as directed by the Engineer or as may be required for a complete and fully functional electrical installation.
- B. It is the intent and purpose of these specifications, accompanying drawings and all other contract documents to cover and include each item, all materials, equipment, apparatus, and labor necessary to properly install, equip, adjust, and put into perfect operation the respective portions of the installations specified and to so interconnect the various items or sections of the work as to form a complete and properly operating whole.
- C. Drawings and specifications have been prepared with best knowledge of conditions available at the time of design and are intended to be complementary. What is called for by one shall be as

binding as if called for by both. Where conflicts occur between drawings and specifications, or between the Electrical documents and the documents of other disciplines, the situation shall be brought to the attention of the Design Professional before the work in question is installed. In case of conflict between provisions of the Specifications or between the drawings and the specifications, the more stringent requirement shall govern. Where a requirement is applied to a specific product, condition, system or Specification Section which conflicts with a more general requirement elsewhere, the specific shall supersede the general. If any obscurities or discrepancies exist, they shall be brought to the attention of the Design Professional before bids are submitted. If they are not discovered before bids are submitted, the Design Professional shall be notified and shall render a decision. This decision shall be final.

- D. Any equipment, apparatus, machinery, material and small items not mentioned in detail, and labor not hereinafter specifically mentioned, which may be found necessary to complete or perfect any portion of the installation in a substantial manner, and in compliance with the requirements stated, implied or intended in these specifications shall be furnished without extra cost. This shall include all materials, devices or methods peculiar to the machinery, equipment, apparatus, or systems furnished and installed as part of the ELECTRICAL work and shall include major components if so required.
- E. The general arrangement of conduit, wiring and equipment shall be as identified on the contract drawings. Carefully examine all contract drawings and be responsible for the proper fitting of materials and equipment in each location as indicated. Inasmuch as the drawings are generally diagrammatic, due to their small scale, it is not possible to indicate all offsets, fittings and accessories, as may be required in the final installation. Carefully investigate the site, structural, and finish conditions affecting their work and arrange such work, accordingly, providing such fittings and accessories as may be required to meet such conditions, at no additional cost to the Owner. The right to make any reasonable change in location of apparatus, equipment, outlets or routing of conduit and wiring, up to the time of roughing-in, is reserved by the Design Professional without involving any additional expense to the Owner.
- F. Should a bidder find discrepancies in or omissions from the drawings or specifications they shall notify the Design Professional before submitting their bid proposal. The Design Professional shall then send written instructions, via Addendum, to all known bidders. Oral instructions shall not be binding to either the Design Professional or the Owner.
- G. In the case of discrepancies or conflicts between the Drawings and Specifications, typically the Drawings will take precedence in the case of quantitative issues, while the Specifications will take precedence for qualitative issues; or as specified in other Divisions; however, when the scale and date of the Drawings are the same, or when a discrepancy exists within the Documents and specific written direction cannot be obtained from the Design Professional, Bidders shall include the most stringent requirements. Obtain written clarification from the Engineer prior to installation.
- H. Any such items not brought to the attention of the Design Professional prior to submission of the bids shall be subject to the interpretation of the Design Professional. All such interpretations shall be accepted by the Contractor and shall be incorporated into the construction in a timely manner, at no additional cost to the contract.
- I. These Specifications are arranged in accordance with the MasterFormat 2016, 35 Division format. Sections of Divisions 26, 27, and 28 are not intended to delegate functions nor to delegate work and supply of materials to any specific trade, but rather to generally designate a basic unit of work. The Specification is to be read as a whole. Items or work called for on one paragraph or Section, shall be applicable to the entire work, unless specifically indicated otherwise. Specific contract scopes shall be as determined by the General Contractor.

#### 1.4 DEFINITIONS:

- A. The following are definitions of words found in the various Sections of Divisions 26, 27, and 28 and on the associated Electrical drawings:
1. "Concealed" shall indicate hidden from normal sight in furred spaces, shafts, ceiling spaces, walls, and partitions.
  2. "Exposed" shall indicate work normally visible, including work in Mechanical or Electrical equipment rooms, tunnels, and similar spaces.
  3. "Provide" (and tenses of "provide") – shall indicate "supply and install, complete in all respects, for a complete and fully functional installation."
  4. "Install" (and tenses of "install") – shall indicate "secure in position, make all final connections complete, test, verify and certify for a complete and fully functional installation."
  5. "Furnish" (and tenses of "furnish" ) – shall indicate "supply only, complete with all required accessories, mounting hardware, etc., for installation by others, or as spare "attic" stock for the Owner's future use."
  6. "Engineer" shall indicate person, firm or Corporation representing the Owner, and identified as such in the Contract Documents. The terms "Engineer" and "Architect" may be used interchangeably throughout the documents.
  7. "Authority Having Jurisdiction (AHJ)" shall indicate the organization, office, or individual responsible for enforcing the requirements of the applicable codes or standards in the location where the project is to be constructed.
  8. "BAS" shall indicate Building Automation System and which shall also refer to by equivalent to references to "ATC" – Automatic Temperature Controls, "BMS" – Building Management System or "FMS" – Facility Management System. Any and all of these terms and acronyms may be used interchangeably to refer to the same functional system, specified under Divisions 21 - 25.

#### 1.5 LAWS, REGULATIONS AND CODES:

- A. Perform all work in strict compliance with all laws, regulations, and/or codes applying, including all Federal, State and local codes and any other authority having jurisdiction. Wherever drawings or specifications conflict with such regulations they shall be made to conform, and approval of the Design Professional obtained on such changes as may be involved.

#### 1.6 QUALITY ASSURANCE:

- A. Perform all work hereunder in strict accordance with all requirements of the Authorities Having Jurisdiction over this work. The editions currently in force within the local jurisdiction of the following codes, regulations, standards, and specifications, shall be strictly followed throughout prosecution of the work:
1. American National Standards Institute (ANSI)/National Institute of Standards and Technology (NIST)
  2. National Fire Protection Association (NFPA)
  3. NFPA-70 – National Electrical Code (NEC) 2017
  4. NFPA 70E – Standard for Electrical Safety in the Workplace
  5. NFPA 90A – Standard for the Installation of Air-Conditioning and Ventilating Systems 2018.
  6. NFPA-101 – Life Safety Code 2018
  7. National Electrical Manufacturers Association (NEMA)
  8. Institute of Electrical & Electronic Engineers (IEEE)
  9. International Electrical Testing Association (NETA) Acceptance Testing Specifications
  10. Underwriters' Laboratories, Inc. (U.L.)
  11. Reflector and Lamp Manufacturers' Institute (RLM)
  12. International Building Code (IBC) 2018

13. International Energy Conservation Code (IECC) 2018
14. International Mechanical Code (IMC) 2018
15. Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)
16. State Department of Health
17. VA Regulatory Guidance
18. Life Safety PA Uniform Construction Code
19. Pennsylvania Department of General Services
20. American Society for Testing and Materials (ASTM)
21. Safety Code for Elevators and Escalators (AMSE/ANSI A17.1)
22. Occupational Safety and Health Administration (OSHA)
23. ANSI/NECA 1-2015, Standard Practices for Good Workmanship in Electrical Contracting
24. IEEE C2, National Electrical Safety Code (NESC)
25. Facility Guidelines Institute (FGI) Guidelines for Design and Construction of Residential Health, Care, and Support Facilities 2018
26. The Joint Commission
27. State of Pennsylvania Department of Health
28. Penelec
29. Verizon
30. Comcast Cable Television/Xfinity
31. Local Building and Electrical codes, or amendments to the above listed Codes
32. All other applicable Federal, State or Local Codes, Regulations and Legislation
33. Owner's Design Standards

- B. All packaged equipment shall be independently Third Party labeled as a system for its intended use by a Nationally Recognized Testing Laboratory (NRTL) in accordance with the OSHA Federal Regulations 29CFR1910.303 and .399, as well as National Electric Code (NEC, NFPA-70), Article 90.7.

#### 1.7 PERMITS, FEES, AND CERTIFICATES OF APPROVAL:

- A. Unless stated otherwise in General Conditions or Division 01, obtain, and pay for all permits, fees, and licenses required, including those of utilities and Agencies. Provide copies to Design Professional in the quantity requested.
- B. Utility company connection charges and fees will be paid directly by the Owner. Include Power Company and other utility connection charges and fees in the Bid. "Fees" shall include connection charges construction costs, and other such charges by utility companies or service providers. Ascertain such charges during bidding period and include bid price.
- C. As a prerequisite to final acceptance, supply to the Design Professional a Certificate of Inspection from the local Electrical Inspector. Certificate shall cover rough wiring, fixtures, and equipment. All costs for the necessary inspections shall be included in the bid.

#### 1.8 REQUESTS FOR INFORMATION (RFI)

- A. Contractor shall be responsible for submitting Requests for Information (RFI)s when discrepancies arise, logical discrepancies are found on the contract documents, or clarification is necessary. All RFIs must be clearly written and submitted including a suggested solution. All RFIs regarding changes to the intent indicated on plans must be accompanied by sketches, explanation, site pictures, and all other instruments necessary, to clearly convey the issue at hand and the suggested solution. The RFI process may only be utilized for legitimate purposes. RFIs may not be utilized to submit deviation or substitution requests, nor requesting confirmation of scope for items clearly defined on the contract documents, nor related to clarifications that should be resolved through the Contractor's coordination efforts. RFIs that do not comply will be summarily rejected and any delays caused as a result are the responsibility of the Contractor. In

cases where the Contractor does not submit an RFI to clarify an issue and incorrectly proceeds, all work required to resolve such issues to be in compliance with the intent of the contract documents, as determined by the Engineer, shall be the Contractor's responsibility and at no additional cost to the project.

- B. Carefully examine all architectural and structural drawings for the building as well as all of the drawings for electrical, IT/AV/Security, mechanical, plumbing, fire protection and all other disciplines and be responsible for the proper fitting of all material and equipment into the building as planned and without interference with other piping, ductwork, conduit, equipment or structure. Refer to the coordination drawing requirements. Proper judgment shall be exercised to secure best possible headroom, ceiling heights, door and window clearance, and space conditions throughout; to secure neat arrangement for piping, equipment, and conduit, and to overcome all local difficulties and interferences to best advantage. Approval for any and all changes to plans and specifications which may be incurred shall be obtained from the Design Professional and the Owner before proceeding.

#### 1.9 RECORD DRAWINGS:

- A. Throughout the construction keep an accurate, up-to-date record of all deviations of the work between that as shown on the drawings and that which is actually installed.
- B. Obtain a complete set of prints of the Electrical drawings and note changes thereon. Make a complete record in a neat and accurate manner, of all changes and revisions to original design which exist in completed work. As-Built markups shall be updated on a daily basis.
- C. Submit As-Built documents in electronic BIM file format. The project design files will be provided to the Contractor by the Design Professional following proper execution of the Document Release and Indemnity Form as provided by the Design Professional. The electronic files returned by the Contractor shall be fully compatible with the native (Revit \*.rvt file format). In addition, submit a complete set of drawings in PDF format.
- D. Room names and numbers shall be brought up to date to reflect actual project room signage and designations, which may be different from room indications shown on the contract drawings.
- E. The cost of preparing these record drawings shall be borne by the Contractor. When all revisions showing the work as finally installed are made, the prints and BIM files shall be submitted for review and approval by the Design Professional.
- F. Record drawings shall be delivered to Owner within 30 days of project Substantial Completion.

#### 1.10 OPERATION AND MAINTENANCE MANUALS:

- A. Provide for the Owner's Use one (1) hard copy printed version and one (1) electronic copy in PDF format of a facility Operation and Maintenance Manual.
  - 1. Each hard copy Manual shall be bound in an extra heavy duty three-ring loose-leaf binder with the following title lettered on the front "Record and Information Manual (insert name of project)". No sheets larger than 8-1/2" x 11" shall be used, except sheets that may be neatly folded to 8-1/2" x 11" and used as a pullout.
  - 2. Each electronic format Manual shall be provided as a single .PDF file, fully bookmarked and indexed, containing all Owner's Manual data and project drawings.
- B. Provide the following information in each Manual:

1. Cuts of all equipment with manufacturer's technical specifications. Material shall be manufacturer's brochures, catalog cuts, parts lists, wiring diagrams, etc. Also include approved shop drawings.
  2. Operation, Maintenance and Servicing Procedures. Include frequency of inspection, cleaning and adjusting and other attention as may be required in accordance with manufacturer's instructions.
  3. Printed copies of machine generated Panelboard Directories. Also include each Panelboard Directory in editable electronic format files.
  4. Copy of project Warranty.
  5. Contact name, telephone number and email address for obtaining replacement parts and service for all equipment.
  6. Copy of all individual equipment warranties.
  7. Copies of all required Test Reports.
  8. CD-ROM, DVD-ROM or USB drive with all Special Systems drawings in both PDF and editable format.
  9. Printed copy of Short Circuit, Coordination and Arc Flash Study.
  10. Electronic copy of the Short Circuit, Coordination and Arc Flash Study in native software data format, to allow the Study to be updated in the future.
  11. Electronic copy of all Owners Instruction and Training Sessions.
- C. Furnish qualified personnel to instruct the Owner's personnel in the maintenance and operation of all equipment and systems. Instructing personnel shall remain on the job continuously during working hours until such instruction is complete, but not less than 16 hours.
- D. A video recording in digital format (DVD) of the operator training session shall be made during this training period and the DVD submitted to the Owner with the Operation and Maintenance Manuals.
- 1.11 WARRANTY:
- A. The material and workmanship of all parts of the electrical installations specified herein and shown on the drawings shall be warranted unconditionally for a period of one (1) year from date of Project Substantial Completion against mechanical and electrical defects arising from faulty materials or workmanship. Either replacement or repairs shall be made promptly on any defective materials or workmanship without charge for materials, equipment, or labor during that period.
  - B. Manufacturer's warranties on equipment provided under this contract shall be included in the operating and maintenance manuals.
  - C. See specification section regarding restrictions on Early Use of Electrical Equipment.
- 1.12 CORRECTION OF WORK AFTER FINAL PAYMENT AND WARRANTY:
- A. This article is supplementary to Warranty Provisions of Division 01 and General Conditions.
  - B. Final payment shall not relieve the Contractor of responsibility for correction of faulty equipment, materials, and workmanship and, unless otherwise specified, they shall remedy any defects due thereto and pay for damage to other work resulting therefrom, which shall appear within the warranty period specified above.
  - C. Include warranties by the respective equipment manufacturers which shall be subject to the terms and time limits defined under these Divisions of Specifications.
  - D. Warranties furnished by Sub-Contractor and/or equipment manufacturers shall be counter-signed by the related Prime Contractor for joint and/or individual responsibility for subject item.

- E. Manufacturers' equipment guarantees or warranties extending beyond the warranty period described herein shall be transferred to the Owner along with the Contractor's warranties.

## PART 2 - PRODUCTS

### 2.1 MATERIALS AND EQUIPMENT:

- A. All installed materials and equipment shall be new and the best of their kind and shall conform to the grade, quality and standards specified herein.
- B. Unless otherwise specifically stated, all materials and equipment offered under these specifications shall be limited to products regularly produced and recommended by the manufacturer for the service intended. This material and equipment shall have capacities and ratings sufficient to amply meet the requirements of the project. The capacities and ratings shall be in accord with engineering data or other comprehensive literature made available to the public by the manufacturer and in effect at the time of opening of bids.
- C. Equipment shall be installed in accordance with manufacturer's instructions for type and quality of each piece of equipment used. These instructions shall be obtained from the manufacturer and shall be considered part of these specifications. Type, capacity, and application of equipment shall be guaranteed suitable to operate satisfactorily. No experimental material or equipment shall be permitted.

### 2.2 EXCAVATION, BACKFILL AND GRADING:

- A. Provide all excavation, bedding, backfill and final grading work required for the installation of the electrical systems under this project.
- B. All excavation shall be unclassified, including the excavation and removal of all soil, shale, rock, boulders, existing foundations, fill and every kind of sub-surface condition encountered in the excavation area. Perform all excavation of whatever substance encountered, to the depths indicated on the drawings or as required to route electrical utilities to avoid conflicts with new and existing underground utilities. No extra or additional compensation for excavation will be paid under this Contract. It is assumed that all excavation under this Contract will be soil excavation. Perform all excavation of whatever substance encountered, to the depths indicated on the drawings or as required to route electrical utilities to avoid conflicts with new and existing underground utilities. In event that rock is encountered, the Contractor shall be compensated for rock excavation in accordance with the unit prices or soil and rock excavation. Include unit prices for soil and rock excavation and the unit prices for soil excavation to be omitted in the Bid. Rock excavation shall consist of solid rock or boulders over two cubic yards in volume or other material which can only be removed by line drilling or chipping by power equipment; blasting will not be permitted. In event rock is encountered notify the Design Professional of its existence in the areas not to be excavated and accurate measurements of the extent of the rock actually removed shall be made and submitted to the Design Professional.
- C. All excavation shall be made by open cut. The banks of the trenches shall be kept as nearly vertical as safe and practicable. Where required provide sheeting, shoring, and bracing.
- D. All excavation material not required or suitable for fill or backfill shall be removed from the project site and shall be properly and legally disposed of in strict accordance with all applicable laws and regulations.
- E. To protect persons from injury, and to avoid property damage, provide adequate barricades; construction, danger, and warning signs; warning lights; lanterns and guards. All such protections shall be placed and maintained throughout the progress of the construction work and until it is

safe for traffic use. Rules and regulations of the Owner and local authorities respecting safety provisions shall be strictly observed.

- F. Trenches shall be of sufficient width to provide a free working space of not less than 24 in. on each side of the conduit, whichever is greater. Trenches shall also be wide enough to thoroughly compact the backfilling around the conduit or ductbank and to secure a firm bed.
  - G. In earth excavation, the trench shall be carried to the bottom of the conduit. Where rock excavation is encountered, the trench shall be carried to a point 6 in. below the construction. No construction shall be bedded directly upon rock but shall be cushioned by a 6 in. layer of selected crushed stone or gravel.
  - H. Where material is removed below the grade of the bottom of a structure it shall be replaced with concrete of the same quality as the concrete in the structure. Where material is removed below the grade of a trench it shall be replaced with a lean concrete mix. Make no excavation to depth below a line of slope one ft. rise on 2 ft. length from such excavation to bottom of footing on other construction.
  - I. Maintain banks at all times by means of shoring and bracing to avoid cave-in and make good any damage done to property or work of others due to failure to properly shore any excavation. Shoring shall be removed after installation and testing of lines have been approved. Material for shoring shall be placed in accordance with the regulations of the Occupational Safety and Health Agency.
  - J. All excavations shall be left open until inspected and approved by the Design Professional or Inspection Authority. After the work has been installed and inspected, the excavation shall be backfilled with best carefully selected material free from stones, large pebbles, hard lumps or frozen earth. All backfill shall be made in 8 in. layers. The first 2 layers shall be of fine earth, hand tamped. The remainder of the fill over new construction to the surface shall ordinary approved excavated material placed in 8 in. layers and thoroughly compacted to not less than 90% of maximum Modified Density as determined by ASTM D1557-70. No water soaking will be permitted. All excess materials shall be disposed of as directed.
  - K. Where excavation is required under existing walkways and roadways, surface shall be restored with new materials equivalent to the material originally used. Whole cement pavement blocks shall be removed and replaced; removal and repair of partial blocks is not permitted.
  - L. Excavation through unpaved areas shall be seeded and straw covered.
  - M. Provide poly plastic warning tape, 6" wide, with foil backing, imprinted "CAUTION BURIED ELECTRIC LINE BELOW" continuously along full length of all trenches above all direct buried cables, and conduits and ductbanks. Tape shall be printed with black ink on APWA (American Public Works Association) and Penelec approved color. Tape shall be minimum 12" below grade. Tape shall be Seton or approved equal.
- 2.3 PUMPING/DEWATERING:
- A. Provide pumping equipment to pump all water to prevent it from collecting in trenches, basement areas, and any other excavations necessary to carry out contract requirements. Prepare run-off trenches as required to pump water into and use surplus earth to form dam at top of excavation to run back surface water.



## 2.4 CHASES AND OPENINGS:

- A. Provide information to the appropriate trades regarding size and location of all openings and chases for the installation of this Electrical Work.

## 2.5 CUTTING AND PATCHING:

- A. Provide all cutting, channeling, chasing, and patching required for work performed under this Contract.
- B. No holes may be cut or drilled in structural members without prior approval of Owner's Representative and Design Professional. Cutting shall be done by mechanics skilled in their respective trades.
- C. No cutting that may impair the strength of the building construction shall be done. No holes may be drilled in or attachments welded to the beams or other structural members without prior approval from the Owner's Representative and Design Professional. All work shall be done by mechanics skilled in their trade.
- D. Provide sleeves for conduits passing through poured concrete decks, footings, walls, etc. Cut all openings for conduits passing through precast concrete or existing concrete masonry. Such holes shall be cut with core drill or similar equipment. They shall not be cut with hammer or chisel, or with any power tool depending on impact for its cutting power.
- E. All patching shall be done in a manner to match appearances and quality of existing surfaces and shall be performed by mechanics skilled in their trade.

## 2.6 CONCRETE:

- A. Provide concrete housekeeping pads (interior) or foundations (exterior) for all generators, switchboards, transformers, and other floor or at grade mounted electrical equipment.
- B. Concrete shall have a compressive strength of 3,000 psi minimum at twenty-eight days. Placing of reinforcing steel and concrete shall be done according to the recommendations of the American Concrete Institute and Concrete Reinforcing Steel Institute, and all materials shall conform to American Society for Testing Materials Specifications, applicable to this work. Equipment pads shall be properly dowelled in with floor construction and shall have sloped bevels on all horizontal and vertical edges. Concrete shall be as specified under Division 03 – Concrete. Provide to the appropriate trade all information required to properly complete concrete work.
- C. Form work shall be of sufficient strength to maintain desired shape during pouring of concrete and tight enough to prevent leakage of the grout through joints.
- D. Submit shop drawings for approval showing dimensions, reinforcing, and dowelling.
- E. Equipment Pads and Foundations
  1. Unless otherwise indicated or required, concrete housekeeping pads or foundations shall extend a minimum of 4-inches beyond the equipment base in all directions and shall be a minimum of 6 inches above floor or grade.
  2. The top edges shall be chamfered.
  3. The surface finish shall be the same as the adjacent surrounding floor.
  4. Interior concrete housekeeping pads shall be securely anchored to the floor slab with steel dowels.

5. Where indoor equipment weight is such that the floor slab will support the equipment and no housekeeping pad is indicated on the drawings, bolt the equipment directly to the floor slab.
  6. Exterior equipment pads shall be turned down on all sides to a minimum of 6" below the frost line as defined by the building code.
- F. Furnish and set, with proper templates, at the time of pouring concrete, all anchor bolts and inserts required for the proper attachment of equipment to the concrete foundations. Anchor bolts shall be of the size and quantity required by the equipment manufacturer and shall be in accordance with the requirements detailed on the drawings and/or specified for the equipment.
  - G. Drop-in wedge anchor bolts or self-drilling anchors may be used in place of hook bolts for equipment other than light poles. Minimum embedment in concrete of wedge anchor bolts shall be in accordance with manufacturer's instructions. Wedge anchor bolts shall be manufacturer by Phillips Drill Co. or USM Corp. Self-drilling anchors shall be manufactured by Phillips Drill Co.
  - H. After equipment is set in place and bolted down, any space between equipment base and floor slab or foundation shall be completely filled with non-shrink grout equal to Master Builders Co., Ltd. Embeco 153 grout.

## 2.7 TESTING AND ENERGIZING:

- A. Provide all labor, materials, instruments, fuel and power required to perform all necessary tests on all electrical systems (feeders, branch circuits, power distribution systems, electrical equipment, etc.). All tests shall be performed in accordance with industry standards and recommendations of the equipment manufacturer, and to the satisfaction of the Design Professional. All defective materials and/or workmanship discovered as a result of these tests, shall be removed and replaced at the Contractor's expense and the test shall be repeated until all associated work passes the test.
- B. Test the entire electrical system in accordance with all applicable requirements of the latest edition of the InterNational Electrical Testing Association (NETA) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems (ANSI/NETA ATS) and ANSI/NETA Standard for Electrical Commissioning Specifications for Electrical Power Equipment and Systems.
- C. On completion of the installation and wiring covered by this Specification the installation shall be thoroughly proved free from grounds and short circuits and left ready for operation. Necessary adjustments to all equipment shall be made in cooperation with the equipment manufacturer.
- D. Balance all three-phase panels to within a maximum of ten percent (10%) imbalance. Submit a report of current readings obtained for each panel after balancing has been completed.
- E. Test all special systems or equipment for proper operation as described in the respective specification sections.
- F. Test all motors for proper rotation. Indicate that rotation by affixing an adhesive arrow, equal to Brady Label Co., to the end bell or case of the motor.
- G. All Test Reports shall list the design standard value; the actual recorded value and the acceptable range of values.
- H. Certify by letter on Company letterhead, that all of the above testing has been successfully completed.

## 2.8 ELECTRICAL EQUIPMENT BY OTHERS:

- A. All electrical equipment furnished and installed under other than Divisions 26, 27, and 28 will be furnished with the full complement of control equipment, starters, control wiring conduit and all other items necessary for satisfactory operation, unless specifically indicated otherwise on the Electrical drawings.
- B. Provide disconnect switches for all motor driven equipment with starters not in sight of panelboard, except when combination motor starters are furnished under other Divisions or where packaged control panels are mounted on equipment by equipment manufacturer. Refer to schedules on HVAC and Plumbing drawings for such packaged systems provided with combination starters. Refer to the HVAC and Plumbing Specifications for packaged control panels. Provide disconnect switches at motors when motors are located out of sight of starters or where otherwise required by National Electrical Code. Disconnect switches shall be lockable in the off position.
- C. Mount all starters or unmounted control panels furnished by other Divisions and complete electrical power connections through the disconnect, starter and motor or other device terminals. Make all final power and other connections.
  - 1. Where packaged control panels are furnished by other trades for equipment such as cooling towers, air handling units, package rooftop HVAC units, condensing units, or similar items, provide all wiring required to connect the motors, contactors, heating elements, sensors, etc., of that equipment to the central panel per wiring diagrams provided by the equipment manufacturer.
  - 2. It shall be assumed that all wiring instructions provided by equipment manufacturers describe wiring methods, materials, and equipment that complies with the requirements of the National Electrical Code, latest edition. If any such given instruction is found to result in non-NEC compliant conditions, stop work and request direction from Design Professional.
- D. Single phase motors integral with equipment (heat pumps, unit ventilators, unit heaters, VAV boxes, and similar HVAC equipment; sump pumps, circulators, and similar plumbing equipment) will be furnished with integral or equipment mounted overload heaters provided with the units. Provide a motor rated toggle-type disconnect switch for each unit where shown. If the motor or equipment does not have integral overload protection, the HVAC, Plumbing Contractor or equipment supplier will furnish a switch with thermal overload element(s) for installation by the Electrical Contractor.
- E. Where equipment supplied by others is controlled by line-voltage devices (thermostats, speed controllers, timers, etc.), these devices will be furnished for mounting and wiring to the Electrical Contractor by the other trades. Refer to HVAC and Plumbing drawings as well as Electrical drawing for these devices. Install devices and make all final connections as may be required.
- F. Complete all power wiring for single phase equipment, through the disconnect and/or the thermal cutouts and local control stations to the equipment, and make all final connections as required.
- G. Certain equipment will be furnished and set in place by others. Obtain dimensioned equipment drawings, wiring diagrams, and other installation data as may be required to properly complete rough-ins and final connections.
- H. Provide all rough-ins and make all final connections for the various electrical services required for all Owner furnished equipment. Obtain from Owner, dimensioned equipment drawings, wiring diagrams, and other installation data as may be required to properly complete rough-ins and final connections.

## 2.9 OWNER FURNISHED (PRE-PURCHASED) EQUIPMENT:

- A. Install and make ready for use Owner Furnished (Pre-Purchased) Equipment as shown on the drawings or hereinafter specified. Provide all labor, miscellaneous materials, equipment, testing services, etc. as necessary to completely install and make ready for proper use the pre-purchased electrical equipment, in its final location in the project. It is the intent that systems be installed complete, with all items necessary, to accomplish this purpose. Provide all required mounting accessories, miscellaneous equipment, concrete housekeeping pads, etc., as required for a complete, fully functional, properly operating installation.
- B. The work includes the scheduling, delivery, receipt, handling, protection, installation, start-up and warranty of all equipment being purchased by the Owner. The Owner will be pre-purchasing the following equipment for this project:
  - 1. Switchboards
  - 2. Panelboards
  - 3. Generators
  - 4. Automatic Transfer Switch(es)
- C. Fully coordinate all work with the equipment which has been pre-purchased by the Owner. Note that although the cost for purchasing, storage, and delivery to the site is being borne by the Owner, the contractor shall, in all other respects, be responsible for the complete installation, start-up, testing, commissioning, warranty and proper operation of the equipment.

## 2.10 SUBSTITUTIONS:

- A. Equipment may be shown or specified in several ways:
  - 1. Manufacturer and catalogue or model number with the words "no substitutions," "no equal," "(manufacturer) only," or words of similar respect: Furnish the specified item.:
  - 2. Several manufacturers and model numbers listed; or one manufacturer and model number, followed by "equals by (mfr A), (mfr B), (mfr C)," or words of similar respect:
    - a. If one of the manufacturers is listed on the drawings, that manufacturer shall be considered the Basis of Design. If none is so listed, the first manufacturer named in the Specification shall be considered the Basis of Design, and one of the others listed may be considered as Substitutions.
    - b. Where manufacturer's or supplier's name, style and catalog numbers are mentioned in the description of material and equipment in the specifications or on the drawings, it is to be understood that they are for the purpose of setting a standard.
    - c. If Contractor elects to furnish equipment other than the Basis of Design, they shall verify and be responsible for capacities, physical size, weight, electrical requirements, methods of connection to other parts of the system, and all other relevant data.
    - d. Inform the Design Professional of all changes required to other equipment, spaces, structure or systems in order to install the substituted equipment. Furnish all required shop drawings or sketches required for Design Professional and the remainder of the Design Team to evaluate the required changes and shall be responsible for all costs associated with such changes, including costs of design or engineering, if such are necessary, and costs of other trades.
  - 3. Where manufacturer's or supplier's names are listed in conjunction with the manufacturer or supplier that is Basis of Design, they are given to approve the firm name only. Equipment or material submitted by such firms must meet the detailed technical specifications written for the respective item. Contractor shall be responsible for verifying

capacities, physical sizes, weights, electrical requirements, methods of connection to other parts of the system, etc. Contractor shall furnish all required shop drawings for equipment, and for its connection and installation.

- B. If any substituted items are submitted after contracts have been awarded, and there is any question of equality of such items, samples may be required to be submitted both for the item specified and that to be substituted, or, further proof of equality may be required to the entire satisfaction of the Design Professional. In no case shall additional remuneration be allowed because of the rejection of a substitute.
- C. When the equipment is relocated to a place other than that shown on the drawings, or when equipment other than that specified is used, the Contractor shall pay the extra cost of required revisions such as structural steel, concrete, electrical, piping, etc.
- D. The Design Professional's costs to evaluate substitutions and to revise Drawings and Specifications because of substitutions will be paid by the Contractor.

#### 2.11 SHOP DRAWINGS:

- A. Prior to submission of any shop drawing submittals, and not more than thirty (30) days after award of the contract, submit to the Engineer, for approval, a complete list of all Sub-Contractors, Materials and Equipment Manufacturers proposed for the project. This list shall include the proposed manufacturer of all equipment proposed for the project; the local sales agency (not the distributor) for the lighting package, and the vendor for each special/low voltage system.
- B. No shop drawing submittals will be considered for review or approval until the complete lists of sub-contractors, and materials and equipment manufacturers have been received and approved by the Engineer.
- C. Furnish shop drawings, catalog cuts, performance data and other required data to the Design Professional for approval for all material and equipment specified hereinafter. Sufficient data shall be submitted to show compliance with the requirements of the plans and specifications. All shop drawings submitted shall be first checked and corrected before submitting for approval. Approval for shop drawings by the Design Professional will not relieve the Contractor from responsibility for errors or omissions therein. All such errors or omissions must be made good by the Contractor irrespective of any approval by the Design Professional.
- D. The following applies to all materials and equipment being submitted for this project. Refer to the individual specification sections for additional submittal requirements.
- E. It is the responsibility of the manufacturer's representative and the installing contractor to thoroughly review all shop drawing equipment submittals and state in writing that the products meet or exceed the design specifications and design intent as indicated on the contract documents, prior to submitting them for review by the Engineer.
- F. The General Contractor shall review and stamp all shop drawings noting their review process has taken place and that the shop drawings are in compliance with the design documents, prior to submitting the for review by the engineer. Any shop drawings found to not be in compliance shall be returned to the contractor stating such, with a copy of the statement (only) forwarded to the engineer.
- G. On submissions beyond the initial one, clearly identify all of the changes made from the initial submittal those requested by the Design Professional will review only those changes they requested and those identified by the Contractor.

- H. The Engineer will review up to three (3) submissions (one original submission and up to two (2) revised submissions) on any single component requested for review. If the contractor and/or vendor fail to comply with the drawings, specifications, and/or review comments and additional submissions are required, the cost for review and processing of those submissions will be borne by the contractor, OR if, in the Engineers opinion, it is felt that the submitted equipment cannot meet the project requirements, the Basis of Deign equipment shall be provided at no additional cost.
- I. The design documents are based and coordinated on the scheduled manufacturers. Any substitutions of products or materials (from those approved and listed in the specifications) must be thoroughly coordinated by the submitting contractor. This includes but is not limited to power, space, structural, control and performance requirements.
- J. Prepare and submit detailed dimensioned shop drawings, together with wiring diagrams, specifications, and operating data, for all specifically fabricated or designed equipment modified from standard items. Shop drawings shall include, but are not necessarily limited to, the following equipment or systems:

Equipment or System	Include in List of Manufacturers	Catalog Data Sheets	Detailed Quantity Take-Off	Dimension Shop Drawings	Special Systems Drawings	Comments
Branch Circuit Panelboards	X	X	X			
Distribution Panelboards	X	X	X	X		
Switchboards	X	X	X	X		
Surge Suppression Devices (SPD)	X	X	X			
Fuses and Circuit Breakers	X	X	X			
Dry Type Transformers (600 volts & below)	X	X	X	X		
Disconnects (Safety Switches)	X	X	X			
Conduits and Raceways	X					
Outlet Boxes	X					
Pull Boxes, Wire Troughs	X					
Wire and Cable (600 Volt & below)	X					
Wiring Devices	X	X				
Time Clocks	X					
Grounding	X					
Sleeves, Hangers, Supports	X					
Lighting Fixtures and Lamps	X	X	X			
Fire Alarm and Signaling System	X	X	X		X	
Generator(s)	X	X		X		
Automatic and Manual Transfer Switch(es)	X	X	X	X		

K. Special System Drawings:

1. Prepare Special Systems Drawings for each of the low voltage systems specified in Divisions 27 and 28. These shall include, but are not necessarily limited to:
  - a. Fire Alarm and Detection System
  - b. Security Systems:
    - 1) Intrusion Detection System

- 2) Access Control System
  - 3) Video Camera/Monitoring System
- c. Sound Systems
  - d. Nurse Call System
  - e. Television Signal Distribution System
2. The Special Systems Drawings shall be of the same size as the contract drawings, and shall consist of plans of the building, drawn to an appropriate scale. These drawings shall consist of original drawings prepared by the Contractor and shall not consist of marked-up prints of contract drawings. All system devices, and their interconnecting wiring and raceways shall be indicated on the drawings. The drawings shall show each device in the project, along with the room name and number in which it occurs, the type and mounting of the device, and the zone or system address of the device as appropriate to the specific system. Each system shall be drawn on a separate set of drawings. These drawings shall indicate installation details, raceway routing, wiring quantities and sizes, wiring connections, wiring color codes and system configuration.
  3. The drawings shall be prepared using BIM360 Revit 2020 for use in a Microsoft Windows 10™ operating environment. The project design files will be provided to the Contractor by the Design Professional following proper execution of the Document Release and Indemnity Form as provided by the Design Professional.
  4. At the completion of the project, all Special Systems drawings shall be brought fully up-to-date to indicate all as-built conditions, including field modifications, conduit routings, wiring connections, etc. Room names and numbers shall reflect actual project room signage and designations, which may be different from room indications shown on the contract drawings.
  5. Full size prints of these As-Built drawings shall be included in the building Operation and Maintenance Manuals, along with electronic copies in PDF format.
  6. The original files prepared in (Revit \*.rvt file format) software shall be turned over in their editable native electronic format as part of the project close-out documents.
- L. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristic, finishes for materials, and installation and startup instructions for each type of product indicated.
  - M. Each control device labeled with setting or adjustable range of control.
  - N. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    1. Schematic flow diagrams showing all controlled equipment and control devices.
    2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
    3. Details of control panel and equipment rack faces, including controls, instruments, and labeling.
    4. Written description of sequence of operation.
    5. Trunk cable schematic showing programmable control unit locations and trunk data conductors.
    6. Listing of connected data points, including connected control unit and input device.
    7. System graphics indicating monitored systems, data (connected and simulated) point addresses, and operator notations.
    8. System configuration showing peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.

- O. Shop Drawings shall be submitted and shall consist of a complete list of equipment and materials, including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. Shop drawings shall also contain complete wiring, routing, schematic diagrams, tag number of devices, software descriptions, calculations, and any other details required to demonstrate that the system will function properly. Drawings shall show proposed layout and installation of all equipment and the relationship to other parts of the work.
- P. Shop Drawings shall be approved before any equipment is installed. Therefore, shop drawings must be submitted in time for review so that all installations can be completed per the project completion schedule. Ten (10) working days shall be allowed for submittals to be reviewed.
- Q. All drawings shall be reviewed after the final system checkout and updated or corrected to provide "as-built" drawings to show exact installation. All shop drawings will be acknowledged in writing before installation is started and again after the final checkout of the system. The system will not be considered complete until the "as-built" drawings have received their final approval. The Contractor shall deliver a complete set of "as-built" drawings.
- R. On submissions beyond the initial one, clearly identify changes made from the initial submittal other than those requested by the Design Professional. The Design Professional will review only those changes they requested and those identified by the Contractor.
- S. If the Contractor elects to proceed to install equipment for which approved Shop Drawings have not been received, they do so at their own risk; the Owner and Design Professional are not obligated to accept such equipment or work, nor will the Owner or Design Professional be liable for claimed costs or delays required by correction of such work.
- T. Shop Drawing Review Comment Definitions:
- A> No Exception Taken:
- The shop drawing or equipment submittal as submitted is approved without exception. No changes or corrections required. The materials, equipment or system submitted can be released for fabrication and construction. No Further Submission Required.
- B> Make Corrections Noted:
- The shop drawing or equipment submittal as submitted is not completely correct but is approved as noted. Make the corrections noted on the shop drawing or submittal. The materials, equipment or system submitted can be released for fabrication and construction once the corrections have been made. The submittal must be corrected and resubmitted for record unless noted by "E: Resubmit". See "E: Resubmit definition below.
- C> Submit Specified Item:
- The shop drawing or equipment submittal as submitted is missing a component of the system that it represents or is not of the approved and specified manufacturers. Submit the missing or incorrect item. The materials, equipment or system submitted cannot be released for fabrication and construction.
- D> No Further Submission Required:
- The shop drawing or equipment submittal as submitted is approved as noted. No changes or corrections required. The materials, equipment or system submitted can be released for fabrication and construction. No Further Submission Required.



E> Resubmit:

The shop drawing or equipment submittal as submitted is not approved. The shop drawing or equipment submittal needs significant corrections and does require another submission to verify that the comments and changes have been incorporated. Make the corrections noted on the shop drawing or submittal. The materials, equipment or system submitted cannot be released for fabrication and construction.

F> Rejected:

The shop drawing or equipment submitted is not as specified or a non-approved manufacturer or product and rejected.

G> Resubmit for Record Only:

Make the corrections noted on the shop drawing or submittal. The shop drawing or equipment submittal as submitted is approved with minor exception. Changes or corrections are required. The materials, equipment or system submitted can be released for fabrication and construction.

- U. Refer to the Project General Conditions and Division 01 Requirements for additional shop drawing submittal requirements, as well as specific requirements in various Divisions 26-28 Technical Specifications.

### PART 3 - EXECUTION

#### 3.1 VISIT THE SITE PRIOR TO PLACING BID:

- A. Visit the site and observe the conditions under which the work shall be performed or other circumstances which will affect the contemplated work.
- B. Bidders shall thoroughly familiarize themselves with all installation parameters, including means and methods of getting equipment and materials into and out of the facility.
- C. No subsequent allowance will be made for any error, omission or negligence on the Contractor's part.

#### 3.2 WORKMANSHIP:

- A. All work shall be installed in a first class, neat and workmanlike manner by mechanics skilled in the trade involved. All details of the installation shall be mechanically and electrically correct. Should the Design Professional direct removal, change, or installation of any equipment or systems not installed in a neat and workmanlike manner, such charges shall be made by the Electrical Contractor at no expense to the Owner.
- B. Equipment shall be installed in strict accordance with manufacturer's instructions for type and capacity of each piece of equipment used. The Contractor shall obtain these instructions from the manufacturer and these instructions shall be considered part of these Specifications.
- C. Drawings are generally indicative of the work to be installed, but do not indicate all conduit bends, fittings, pullboxes, and specialties which may be required, or the exact locations of all conduits. Investigate structure and finish conditions affecting the work, along with the work installed by other trades and arrange the work accordingly; furnish such fittings and appurtenances as may be required to meet such conditions. Contractor is responsible for exercising proper judgment to arrange their work and materials so as to avoid interference with other trades.

1. The essentially diagrammatic nature of drawings shall not be interpreted as reason to redesign project. While raceways or cables shall be installed as required by local conditions rather than exactly as may be shown, all outlets indicated on one circuit shall be so installed. No reduction in size or number of raceways or cables will be permitted. In general, quantity of wires in each raceway or cable has not been indicated but shall be provided as required.
  2. Riser and one line diagrams, details, and schematics generally indicate wiring to be used in various systems involved. This information may or may not be duplicated on the plans, but equipment shown on either plans or Riser or One Line diagrams and schematics shall be provided as if shown on both.
  3. All grades, elevations, dimensions and clearances of equipment shown on drawings are approximate and shall be verified at site.
  4. Where work or equipment is referred to in singular terms, such reference shall be deemed to apply to as many items of work or equipment as required to complete entire installation.
- D. Electrical junction boxes, pull boxes, panel boards, switches and controls and other apparatus requiring periodic maintenance and operation shall be accessible.

### 3.3 LINES AND GRADES:

- A. A competent Electrical Foreman shall be on the premises at all times during the construction to check, layout, coordinate and superintend the installation of the work performed under Divisions 26-28. Submit a complete resume for the foreman proposed for this particular project, along with a list of at least ten (10) similar projects, including construction dates and Owner's contact information (name, organization, address, telephone and email). The foreman shall be approved by the Owner and Design Professional prior to start of construction.
- B. Establish all grades and lines relative to the work before any work has been started and be responsible for the accuracy thereof.
- C. Lay out work and establish heights and grades for work in strict accordance with the intent expressed by the drawings and all the physical conditions at the building and be responsible for the accuracy of same.

### 3.4 FIELD MEASUREMENTS:

- A. Before ordering any material or doing any work, verify all measurements at the building and site and be responsible for the correctness of same. No extra compensation will be allowed on account of differences between actual dimensions and measurements and those indicated on the drawings. Any difference which may be found shall be submitted to the Design Professional for consideration before proceeding any further with the work.

### 3.5 DELIVERY OF EQUIPMENT:

- A. Be responsible for delivery of equipment, unload and store in a manner not to interfere with the operation of other trades. Additional expense incurred because of equipment or material delivery delays shall be assumed by the responsible Contractor.

### 3.6 RESTRICTIONS ON EARLY USE OF ELECTRICAL EQUIPMENT:

- A. Any electrical equipment placed into service and used prior to project Substantial Completion shall be used at the onus of the contractor and they shall assume full responsibility for repairing or replacing any equipment damaged as a result of the use and pay all costs associated with the action required to restore the equipment to "like new" condition at the end of the project. This includes extension of warranties, payment of Design Professional fees required to investigate and

enforce this requirement, and the correction of any other detrimental conditions which is determined by the Design Professional to be related to the early use of the equipment.

- B. Should the early use of equipment result in manufacturer's warranty being void or of limited duration, the contractor shall assume the cost of furnishing an equivalent warranty to the Owner. Refer to Article "Warranty" in Part 1 above.

### 3.7 PROTECTION OF WORK:

- A. All work, equipment and materials shall be protected at all times. All raceway openings shall be closed with caps or plugs during the installation. All equipment shall be tightly covered and protected against dirt, water, plaster, paint and other foreign material or mechanical injury during entire progress of installation. Make good all damage caused either directly or indirectly by workmen employed to fulfill requirements of the Electrical Work.

### 3.8 REMOVAL OF RUBBISH:

- A. During the course of construction, periodically remove from the premises all trash, rubbish and miscellaneous debris resulting from work of this trade so as to prevent its accumulation. At the completion of the work contemplated under these Specifications remove from the building and site all rubbish and accumulated materials of whatever nature not caused by the other trades and leave work, and equipment free of all foreign matter including plaster, cement, and paint and leave in a clean, orderly, acceptable and usable condition.

### 3.9 COORDINATION WITH OTHER TRADES:

- A. Coordinate the entire electrical installation with the work of all other trades on the project to provide a fully coordinated installation, with proper access to all equipment requiring same, proper electric service to each piece of equipment requiring electrical power and proper provisions for servicing and maintenance of all equipment of all trades. Install electrical raceways and equipment to minimize interference with other trades and allow proper access to all equipment of all trades. Follow National Electrical Code requirements for equipment access and clearances.
- B. Coordinate installation of electrical fixtures and devices in the ceiling with the Reflected Ceiling Plans, including Reflected Ceiling submittals where provided. Verify ceiling types and provide all required accessories, mounting hardware, trims and miscellaneous hardware for proper installation and support of each fixture or device in the ceiling type it is to be installed. Where fixtures or devices do not occupy a full ceiling tile, center the fixture or device within the individual ceiling tile in which it occurs. In no case shall electrical devices be supported solely by the ceiling tile or ceiling finish material. Provide suitable mounted brackets or hardware for support of the device by the ceiling support system, and provide additional support wires from the building structure to prevent sagging or decoupling of the ceiling system. Coordinate all ceiling mounted devices, including those of other trades. The order of precedence for locating ceiling devices shall be generally as follows:

1. Building Structure
2. Bulkheads and Architectural Features
3. Exit Signs
4. Lighting Fixtures
5. HVAC Air Devices
6. Sprinkler Heads
7. Fire Alarm Devices
8. Speakers
9. Other devices

Where conflicts in the above order of precedence exist, they shall be brought to the attention of the Design Professional for resolution.

- C. Coordinate locations of wall mounted devices with chalk and tack boards, projection screens or video equipment, casework, countertops, artwork and other architectural appurtenances. Refer to Architectural plans and elevations for additional information. Locate lighting control devices on latch side of door. Verify all door swings with the Architectural drawings prior to rough in. Verify casework and countertop arrangements with approved casework shop drawings.
- D. Do not depend solely on the electrical drawings to determine building construction arrangements including, but not limited to, ceiling types, door swings, wall types, and structure. Verify actual conditions base on the individual discipline documents, approved submittals and approved equipment cuts.
- E. Wherever possible obtain approved submittals for all equipment to confirm electrical power requirements and rough-in locations prior to installation of rough-ins.
- F. Minor relocations of outlets, devices, fixtures and rough-in locations is to be expected prior to rough-in, and shall be accommodated at no additional cost.
- G. Participate in on-going contractor coordination efforts in order to create a finalized, well-coordinated layout of all equipment, fixtures, devices, raceways and all other items within their respective scope. The coordination effort shall include coordinating information from all other trade contractors involved in the project scope[, all existing conditions, and all new work in order to provide a complete and thorough coordination effort. Any work which must be modified due to lack of coordination shall be the responsibility of the Contractor and shall be corrected at no additional cost to the project. Minor relocations and shifts of equipment and raceways, which do not change the design intent indicated on the contract documents, required to accommodate field conditions, and which do not involve changes in project cost or schedule, may be made at the Contractor's discretion and do not require Design Professional's approval.
- H. Room names and numbers used in final As-Built/Record documentation shall be based on actual room names and numbers in use at the facility, and are not necessarily those shown on the contract documents.

### 3.10 COORDINATION DOCUMENTS:

- A. Participate in creation and maintenance of working Revit construction model coordination drawings. At the start of construction, following proper execution of a Document Release and Indemnity Form provided by the Design Professional, the Design Professional will provide copies of the Revit Model to the Contractor for their use in creating these working construction documents. These documents shall be created in the latest version of Revit software in the native Revit \*.rvt file format. These shall be used to update the contract drawings for use as working Coordinated Installation Documents.
- B. Periodic Contractor Coordination Meetings will be held under the supervision of the General Contractor for the purpose of exchanging coordination information, resolving installation conflicts, laying out the exact location and routing of their work and updating the Revit model as working Coordinated Installation Documents. Each trade shall have proper representation at all Coordination Meetings. After the conclusion of the coordination at the working meetings, each trade shall update the working Installation Documents, and the updated Coordinated Installation Documents shall be posted to a project website hosted by the General Contractor.

- C. Throughout the construction of the project, the BIM Model shall be maintained at LOD (Level of Detail) 400 per BIM Forum, Level of Development Specification 2015, (<https://bim-international.com/wp-content/uploads/2016/03/LOD-Specification-2015.pdf>). As equipment submittals are approved, the BIM Model shall be rough up to date using Revit families obtained from the approved equipment manufacturers. This shall include, but is not necessarily limited to: Switchgear, switchboards, panelboards, disconnect switches, enclosed circuit breakers, motor starters, variable frequency drives, control panels, equipment cabinets, lighting fixtures, etc. The actual routing of conduits 2" and larger shall be shown including all pull and junction boxes, offsets, bends, etc.
- D. Dimensioned layout plans of equipment rooms shall be provided showing all equipment, housekeeping pads, major pullboxes and raceways; suitable for coordination with other trades.
- E. Furnish all necessary templates, patterns, etc. for installing work and for purpose of making adjoining work conform, furnish setting plans and shop details to other trades as required.
- F. At the completion of the project, immediately following Substantial Completion, the BIM Model shall be brought to a final LOD 400 status, and electronic files of the completed model shall be provided to the Design Professional and Owner.

### 3.11 COORDINATION OF ELECTRICAL CHARACTERISTICS:

- A. It is the intention and requirement of this specification that the proper electrical service be provided to all pieces of equipment on the project requiring same. As far as is possible, the proper service to each piece of equipment has been indicated on the plans. Verify the service requirements of all pieces of equipment before making final provisions. All manufacturer's details shall be available for check before installation. Check the exact point of connection for each piece of equipment so that the service may be brought to the proper location. Locations indicated on the plans are diagrammatic and approximate only.
- B. Carefully examine the drawings of all other trades for equipment requiring electrical connection to confirm that all electrical characteristics of equipment indicated thereon matches the service available. Wherever possible, obtain approved shop drawings and equipment rough-in drawings for the actual item of equipment to be installed prior to rough-in. This shall apply to all equipment, whether it is to be installed by the contractor or by the Owner.
- C. If any discrepancies are noted, immediately notify the Design Professional and request resolution. If characteristics are correct, Electrical Contractor is responsible for ascertaining method of connection, "rough-in" dimensions, correct plug and receptacle configurations, etc. While Design Professional has made every effort to provide such information as is known at time of design, Contractor shall obtain final data from approved shop drawings before proceeding.
- D. For all equipment of other trades which electrical characteristics are not indicated on the drawings of that trade, notify the Contractor furnishing such equipment as to the characteristics required.
- E. Prior to purchase and installation of any motor control equipment (starters, etc.), verify the actual motor electrical characteristics with the approved equipment shop drawings. Starter overloads shall be sized in accordance with actual motor nameplate running load amperes.

### 3.12 FIRE STOPPING:

- A. Coordinate with the Architectural drawings to determine specific fire and smoke penetration ratings of building structural elements. Electrical work shall be installed so as to maintain the fire and smoke penetration ratings of walls and floors through which they enter or pass.

- B. All penetrations through fire-resistance-rated floor, fire resistance rated, floor/ceiling assemblies and roof construction and through fire-resistance-rated walls and partitions shall be fire stopped.
- C. Firestopping materials shall be UL tested and listed as suitable for the specific installation arrangement for which it is to be used. The material shall possess intumescent characteristics and upon exposure to heat above 250 degrees F. shall expand to not less than five times its original volume to fill all voids and form a fireproof envelope, UL rated for 2 and 3 hour protection, when applied in accordance with the manufacturer's recommendations. Firestopping material shall be impervious to water and similar liquids. Sodium silicate based firestopping materials are not acceptable.
- D. Conduit: The annulus between exposed conduit and walls or floors in finished spaces shall be filled, sealed, and painted or otherwise finished to match adjacent surfaces. Single or multiple conduits passing through or entering walls and floors shall have the annulus space between conduits or between conduits and structure filled with firestopping material which maintains the fire rating of the wall or floor.
- E. Future Slots: Identify unused sleeves and slots for future use by permanently anchored nameplates identifying size and purpose of the covered slot.
- F. Large Openings: Large openings in walls or floors shall be infilled with material to match the surrounding building surfaces. Provide suitable studs, angles, beams, lintels etc. as may be required to adequately support infill materials. Allow 1" space between structural infill materials and conduits, cables and electrical work passing through or entering walls or floor slabs. Fill all spaces around conduits, cables and electrical work with intumescent firestopping material as specified above.
- G. Fire rating of sealed penetrations shall meet or exceed the rating of the assembly being penetrated.
- H. Firestopping materials shall be installed in accordance with manufacturer's recommendations and their UL listing.
- I. Refer to Division 07 Section, "Firestopping" for additional information and requirements.

### 3.13 ACCESS DEVICES:

- A. Access doors shown on the Architectural Drawings will be provided under the Architectural Sections of the specification. All other access panels shall be furnished by the Contractor responsible for the work specified under Divisions 26, 27 and 28 of the specifications, for installation under this Section of the specifications, in accordance with the requirements specified herein.
- B. Access panels shall be provided for access to all concealed equipment, junction boxes, control devices, disconnects and other devices above non-accessible ceilings, in vertical chases, or where no other means of access is available. Final size and location of access panels shall be subject to approval by the Design Professional. Cooperate with all other trades so that equipment will be properly accessible through the access panels.
- C. Access doors in surfaces which are fire rated shall be Nystrom Uninsulated Fire-Rated Access Door or approved equal. Provide flange trim as required to suit the wall finish into which it is being installed. Fire Rated Access Doors shall be prime coated. Provide each Fire Rated Access Doors with any other accessories as required. The fire rating shall match the fire rating of fire rated assembly.

- D. Non-fire rated access panels shall be of steel construction, prime coated, shall have front panel fitted flush with the frame, with concealed hinge and latches; and shall be Milcor, Style K or M, or as required to accommodate the adjacent wall and ceiling construction, or equivalent as manufactured by Inland Steel Products Co., Miami-Carey Division of the Philip Carey Mfg. Co., Newman Brothers, Inc., Cesco Products or Larsen's Manufacturing Company.
- E. Provide all access doors (fire rated or not) with mortise lock, keyed as directed by Owner, and any other accessories as required.
- F. Access panels and doors shall be minimum 14" x 14". Final size and location of access panels shall be subject to approval of the Engineer. Cooperate with all other trades so that equipment will be properly accessible through the access panels.

3.14 SHORT CIRCUIT, COORDINATION AND ARC FLASH STUDY:

- A. Provide the services of a firm qualified and experienced in Short Circuit/Coordination and Arc Flash studies to perform a Study on the entire electrical power distribution system in this facility following the approval of circuit protective devices and power distribution equipment. All costs associated with the preparation and updating of the Study to reflect final, as-built project conditions shall be included by the Contractor in their bid.
- B. Include an allowance in the contract cost to change and/or upgrade 25% of the overcurrent protective devices and power distribution equipment to a higher A.I.C. rating and/or different style overcurrent protective device type, to include fuses or relays, as required by the results of the Short Circuit, Coordination and Arc Flash Study for the available fault currents, to provide proper coordination of devices or to reduce arc flash hazards. Where circuit breaker type overcurrent protective devices do not provide proper device coordination, replace circuit breaker type devices with fuse type devices to allow proper coordination. Changes required to meet findings of the Short Circuit, Coordination and Arc Flash Study shall be made at no additional cost to the Owner.
- C. Refer to Section 26 05 73 Power System Studies for additional information and requirements.

3.15 SEISMIC RESTRAINTS:

- A. All electrical equipment and material required by applicable Codes to be installed or supported in accordance with seismic restraint criteria shall be installed in accordance with this Article. This applies to equipment or materials specified in other Division 26, 27, and 28 Specification sections as well as to materials specified in this section.
- B. Engage the services of a registered professional engineer whose practice comprises the design of seismic restraints. All costs for these services shall be included in the bid.
- C. Refer to Structural Drawings and Specifications for additional information and requirements.

3.16 OWNER'S INSTRUCTIONS:

- A. Upon completion of all work provided under these Divisions of the specifications, thoroughly instruct the Owner's representatives in the operation and maintenance of all the various apparatus and equipment to the approval and complete satisfaction of the Engineer. This shall be done after the completed systems have been put in full operating condition and all tests are successfully completed.
  1. Refer to additional Instructional requirements in the various specification sections of Divisions 26, 27 and 28.

- B. Provide factory trained and certified instructors for each training session.
- C. Provide sufficient copies of all training materials, hand-outs, manuals, etc. so that each person in attendance has a copy of all materials.
- D. Provide a minimum of two (2) identical sessions for each training session, to accommodate Owner's Maintenance and Operations personnel on multiple shifts.
- E. Provide high quality professional digital video recordings of all electrical systems demonstrations and instruction sessions.
  - 1. Utilize professional quality video camera(s). Cell phone and similar cameras are not acceptable.
  - 2. Utilize remote microphones as may be required to ensure high quality audio of the recorded demonstrations.
  - 3. Sessions shall be recorded digitally, and the recordings shall be provided to the Owner in standard digital format, viewable on a computer running the Microsoft Windows operating system. Close-out the recording session, and create file index with each pertinent point in the session indexed. Verify compatibility/functionality of each disk prior to submitting to the Owner.
  - 4. Provide three (3) copies of each digital recording for the Owner's record.

END OF SECTION



## SECTION 260005

### COORDINATION DRAWING REQUIREMENTS FOR ELECTRICAL

#### PART 1 – GENERAL

##### 1.1 STUPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 COORDINATION DRAWINGS

- A. All mechanical, electrical, plumbing, fire protection, telecommunications, and ATC subcontractors will be required to use AutoCad (CAD) format. Coordination drawings will be distributed via email and/or disk.

##### 1.3 ABOVE CEILING AND NO CEILING OVERHEAD INSTALLATION

- A. The Mechanical Contractor shall furnish minimum 1/4" scale CAD electronic background drawings of the sheet metal shop drawings, for incorporation of plumbing and mechanical piping services. All ductwork and piping systems shall be thoroughly dimensioned as to location and height above finished floor. Each different system will be drawn in a different color. Upon conclusion of the various systems coordination with the Sheet Metal Contractor, the composite drawing shall be distributed by the Construction Manager for contractor coordination. All lighting fixture locations will be "ghosted in" by the Sheet Metal Contractor for coordination of the same. The Sheet Metal Contractor shall prepare a title box on each drawing which allows space for the signature of the authorized individual from the Sheet Metal, HVAC Piping, Plumbing, Fire Protection, Electrical, Telecommunications and ATC firms, with the statement below:

"The undersigned individual certifies by their signature that they have coordinated their work with all other work noted on this drawing and the contract documents and shall be held responsible for any costs arising out of their respective inability to fully coordinate their work."

NOTE: The composite drawing is in addition to separate shop drawings to be submitted at the conclusion of the coordination process.

- B. At the conclusion of each composite drawing coordination process, the Construction Manager shall be notified by the Mechanical Contractor Project Manager. The Mechanical Contractor Project Manager shall then schedule an on-site coordination meeting for the purpose of signing off on the respective drawing. The Mechanical Contractor shall not be authorized to release any material for fabrication or installation until the composite drawing signature process is executed or until Construction Manager authorizes, in writing, a portion of the work to proceed.
- C. The Mechanical Contractor shall print a weekly status log and maintain a file for the project on this process. Each subcontractor is responsible to submit and coordinate his work with the Construction Manager and Mechanical Contractor.
- D. The Fire Protection Contractor shall overlay his complete piping system on a composite background drawing furnished by the Mechanical Contractor. The Fire Protection Contractor shall utilize a different color from that previously used by the HVAC and Plumbing draftsmen. The Fire Protection Contractor shall cooperate in the coordination process by the relocation of

his piping as required to facilitate coordination. When completed, Sprinkler Contractor's coordination drawing shall be delivered to the Construction Manager. At the conclusion of the entire coordination process, the Fire Protection Contractor shall be responsible for attending a coordination meeting at the jobsite for the purpose of his authorized personnel affixing their signatures to the statement below:

"The undersigned individual certifies by their signature that they have coordinated their work with all other work noted on this drawing and the contract documents and shall be held responsible for any costs arising out of their respective inability to fully coordinate their work."

NOTE: The composite drawing is in addition to a separate sprinkler piping shop drawing to be submitted at the conclusion of the coordination process.

- E. The Electrical Contractor shall be responsible to overlay his major conduit racks and equipment, as well as verifying all lighting fixture locations and heights for coordination with the other trades on a composite drawing prepared by the Mechanical Contractor. All conduits larger than 2" shall be documented. When completed, Electrical Contractor's coordination drawing shall be delivered to the Construction Manager. At the conclusion of the coordination drawing process, the Electrical Contractor shall be responsible to attend a coordination meeting at the jobsite for the purpose of his authorized personnel affixing his signature to the statement below:

"The undersigned individual certifies by their signature that they have coordinated their work with all other work noted on this drawing and the contract documents and shall be held responsible for any costs arising out of their respective inability to fully coordinate their work."

- F. The Plumbing Contractor will be responsible to overlay his major piping racks and equipment, as well as verifying all plumbing fixture locations and heights for coordination with the other trades on a composite drawing prepared by the Mechanical Contractor. When completed, Plumbing Contractor's coordination drawing shall be delivered to the Construction Manager. At the conclusion of the coordination drawing process, the Plumbing Contractor shall be responsible to attend a coordination meeting at the jobsite for the purpose of his authorized personnel affixing his signature to the statement below:

"The undersigned individual certifies by their signature that they have coordinated their work with all other work noted on this drawing and the contract documents and shall be held responsible for any costs arising out of their respective inability to fully coordinate their work."

- G. The Telecommunication Contractor will be responsible to overlay his major communication racks and cable tray, as well as verifying locations and heights for coordination with the other trades on a composite drawing prepared by the Mechanical Contractor. When completed, Telecommunication Contractor's coordination drawing shall be delivered to the Construction Manager. At the conclusion of the coordination drawing process, the Telecommunication Contractor shall be responsible to attend a coordination meeting at the jobsite for the purpose of his authorized personnel affixing his signature to the statement below:

"The undersigned individual certifies by their signature that they have coordinated their work with all other work noted on this drawing and the contract documents and shall be held responsible for any costs arising out of their respective inability to fully coordinate their work."

- H. Provide survey and coordination of underground plumbing for verification of location.

- I. Drawings, if available, may be obtained electronically from the Architect through the Construction Manager.
  - J. The Mechanical, Electrical, Plumbing, Fire Protection, Telecommunication and ATC Contractors shall receive hard copies of all drawings.
  - K. The Mechanical, Electrical, Plumbing, Fire Protection, Telecommunication and ATC Contractors shall review all drawings and advise if any additional drawings are needed.
  - L. The Mechanical Trade Contractor shall take the lead and develop a drawing list for submissions and a submission schedule coordinated with the construction activities. The drawings shall be developed in a sequential fashion so as to no delay installation of the work or the overall project schedule. The lead Mechanical trade contractor shall include a master key plan so that the area of each drawing can be readily identified as to the location within each building. The Plumbing trade contractor shall lead the underground coordination and the HVAC trade contractor shall lead the balance of the coordination work. The drawing list and schedule shall be forwarded to the Construction Manager for review.
  - M. Pursuant to Construction Manager approval of the list and schedule, the Mechanical trade contractor shall provide to all participants the latest plans in a timely fashion in accordance with his schedule.
  - N. Prior to the start of the work, each subcontractor shall forward an insulation schedule to the Construction Manager M.E.P. Coordinator. The schedule shall show the size and thickness of each type of insulation and its intended use.
- 1.4 ACCESS FLOOR INSTALLATION
- A. Coordination drawings for systems to be installed in the access floor shall be prepared in the same manner as described for the overhead installation.
- 1.5 SHEET METAL / PIPING / ATC / ELECTRICAL ACCESS / MAINTENANCE CLEARANCES
- A. As soon as practical, the Mechanical trade contractor shall prepare layout drawings (not less than 3/8" scale) of all ductwork and piping. These drawings shall show all WALL FIRE RATINGS, registers, grilles, diffusers and similar features, as well as locations of all valves, dampers, damper operators and other items requiring access for maintenance. It shall also be the responsibility of the Mechanical trade contractor to show on these drawings; beams with bottom elevations, ceiling heights, wall-to-wall dimensions, partitions, columns, windows, doors, electric lighting layouts as shown on the reflected ceiling plans, acoustical ceiling grid, and other major architectural and structural features as shown on the General Construction Drawings. All dimensions should be from centerlines of columns. All required access to equipment for service and/or required for NEC code required clearances shall be shown in a dotted zone.
  - B. The Mechanical trade contractor, upon completion of his work, shall email his data back to the Plumbing trade contractor and copy all participants. The Plumbing trade contractor shall download the mechanical data and incorporate, by separate layer, his own routing, as well as other areas requiring access for service and maintenance to determine their relationship and possible interferences with the mechanical, architectural, or structural features to be performed as part of the work.
  - C. The Plumbing trade contractor shall then email his data to the Electrical trade contractor and copy all participants. The Electrical trade contractor shall download the drawing and incorporate, by separate layer, his own routings, as well as the depth of all light fixtures, access panels, etc., as required to determine the relationship and possible interferences with plumbing, mechanical, architectural, or structural items to be installed as part of the overall work. The Electrical trade contractor shall be responsible to verify that the electrical lighting layout shown on these drawings

is correct and to make corrections and additions of all other light fixtures as required. In areas where no mechanical work occurs, but where other crowded electrical installations are evident, the Electrical trade contractor shall prepare similar drawings.

- D. The Electrical trade contractor shall then email the Fire Protection trade contractor and copy all participants. The Fire Protection trade contractor shall download the drawing and incorporate, by separate layer, his own routings, as well as other areas requiring access for service and maintenance, to determine their relationship and possible interferences with the mechanical, electrical, plumbing, and architectural or structural items to be installed as part of the overall work.
- E. The Mechanical trade contractor shall provide one composite set of reproducible drawings and forward them to the Construction Manager. This composite shall then be reviewed during meetings determined by the Construction Manager, at which all subcontractors including their subcontractors, as required by the Construction Manager, shall be represented to review and resolve any real or apparent interference or conflicts.
- F. In the preparation of all the final composite drawings, large scale details, as well as cross and longitudinal sections shall be made as required to fully delineate all conditions. Particular attention shall be given to the locations, size and clearance dimensions of equipment items, shafts, and similar features. The final composite drawings shall include the locations of all controls, tie-ins, connections for other subcontractor's work, and pipe and duct insulation as required.
- G. Final composite drawings shall then be signed off by each trade subcontractor indicating their acceptance and approval of the indicated routings and layouts and their relationship with the adjoining or contiguous work of all subcontracts. Thereafter, no unauthorized deviations shall be permitted. If deviations are made without the knowledge and agreement of Construction Manager and other affected trade contractors, the work in question shall be subject to removal and correction at no additional cost.
- H. In preparing the composite drawings, minor changes in duct, pipe or conduit routings that do not affect the intended function may be made as required to avoid space conflicts, when mutually agreed. Items may not be resized, exposed items relocated, or items run exposed when not intended, without approval. No changes shall be made in any structural members or architectural features which affect the function or aesthetics of the buildings. If conflicts or interferences cannot be satisfactorily resolved, the Engineer shall be notified, and his decision obtained.
- I. After final composite drawings have been accepted and approved, and signed by ALL subcontractors, the Mechanical trade contractor shall provide and distribute one sepia and two prints to each of the subcontractors, and one sepia and four prints each to Construction Manager. Subcontractors requiring further prints for their own distribution will possess sepias to accomplish same. The original signed-off mylars shall be sent to Construction Manager for permanent possession.
- J. The record copies of final composite drawings shall be retained by each subcontractor as a working reference. All shop drawings, prior to their submittal to Construction Manager, shall be compared with the composite drawings and developed accordingly by the subcontractor responsible. Any revisions to the composite drawings, which may become necessary during the process of the work, shall be noted by all subcontractors, and shall be neatly and accurately recorded on the record copies. Each trade contractor shall be responsible for the up-to-date maintenance of his own record copies of the composite drawings and to keep one copy available at the site. The composite drawings and any subsequent changes thereto, shall be utilized by each subcontractor in the development of his as-built drawings. NOTE: The coordination drawings may be used with appropriate changes as as-builts and changes to title block.

- K. Preparation of coordination drawings shall commence as soon as possible after award of the subcontract. The coordination drawings may lack complete data in certain instances pending receipt of equipment drawings, but sufficient space shall be allotted for the items affected. When final information is received, such data shall be promptly inserted on the composite by that trade contractor.
- L. Coordination is the responsibility of all trade contractors. Construction Manager will call meetings, weekly, or as required, which subcontractors must attend to avoid delay. Failure to attend shall require the trade contractor to field run the work not coordinated. No extra compensation will be paid to any trade contractor for relocating any duct, pipe, conduit or other material that has been installed without proper coordination. If the installation of any uncoordinated work or improper installation or coordinated work necessitates additional work by other subcontractors, at the cost of such additional work shall be assigned to the trade contractor responsible as determined by Construction Manager.
- M. All changes in the work of any subcontract shall be shown on the composite drawings.
- N. All work on the coordination composite drawings shall be performed by competent CAD operators, in a clear legible manner. Each trade contractor shall execute a typical drawing activity in no more than three working days. It shall be the responsibility of each subcontractor to supply a sufficient number of CAD operators so as not to delay the coordination process. Construction Manager and Engineer shall be the judge of the acceptability of the drawings.
- O. The composite drawings shall not be used for as-built drawings. (See Paragraph above)
- P. It shall be further understood that each trade contractor's specified submittals shall be transmitted for approval during the coordination period in order that the project encounter no delays.
- Q. The Mechanical trade subcontractor shall pre-coordinate all control equipment locations with the designated ATC trade subcontractor and indicate it on the composite document.

#### 1.6 REQUIREMENTS

- A. All Mechanical, Electrical, Plumbing, Fire Protection, Telecommunication and ATC trade contractors shall be required to use AutoCad (CAD) format. Coordination drawings shall be distributed via email or diskettes. ALL EMAILS SHALL BE COPIED TO CONSTRUCTION MANAGER, ENGINEER, AND PROJECT MANAGER.
- B. The Sheet Metal trade contractor shall prepare a title box on each drawing which allows space for the signature of the authorized individual from the sheet metal, HVAC, piping, plumbing, sprinkler, electrical and ATC firms with the statement below:

"The undersigned individual certifies by their signature that they have coordinated their work with all other work noted on this drawing and the contract documents and shall be held responsible for any costs arising out of their respective inability to fully coordinate their work."
- C. The Mechanical trade contractor shall not be authorized to release any material for fabrication or installation until the composite drawing signature process is executed or until Construction Manager authorizes, in writing, a portion of the work to proceed.
- D. The Mechanical Contractor shall print a weekly status of all emails sent and received and maintain a hard copy file for use at the coordination "sign-off" meetings. Each subcontractor is required to check emails daily.

- E. Submittals: Once the coordination process has been completed, the coordination drawings shall be submitted to the Engineer for review. A single-color plot, as well as three blueprint copies of the drawings shall be submitted for review. The color plot shall delineate between the various disciplines by utilizing different color pens for each system.

PART 2 – PRODUCTS (NOT APPLICABLE)

PART 3 – EXECUTION (NOT APPLICABLE)

END OF SECTION

## SECTION 260519

### LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

A. Section Includes:

1. Copper building wire.
2. Nonmetallic underground conduit with conductors, Type NUCC.
3. Metal-clad cable, Type HCF-90 Health Care Facilities.
4. Photovoltaic cable, Type PV.
5. Mineral-insulated cable, Type MI.
6. Tray cable, Type TC.
7. Fire-alarm wire and cable.
8. Connectors and splices.

B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.
2. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.
3. Section 271313 "Communications Copper Backbone Cabling" for twisted pair cabling used for data circuits.
4. Section 271513 "Communications Copper Horizontal Cabling" for twisted pair cabling used for data circuits.

##### 1.3 ACTION SUBMITTALS

A. Product Data:

1. Copper building wire.
2. Nonmetallic underground conduit with conductors, Type NUCC.
3. Metal-clad cable, Type HCF-90 Health Care Facilities.
4. Photovoltaic cable, Type PV.
5. Mineral-insulated cable, Type MI.
6. Tray cable, Type TC.
7. Fire-alarm wire and cable.
8. Connectors and splices.

B. Product Schedule: Indicate type, use, location, and termination locations.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

### PART 2 - PRODUCTS

#### 2.1 COPPER BUILDING WIRE

- A. Description: Flexible, insulated, and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. General Cable; Prysmian Group North America.
  - 2. Southwire Company, LLC.
- C. Standards:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
  - 2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
- E. Conductor Insulation:
  - 1. Type THHN and Type THWN-2. Comply with UL 83.
  - 2. Type UF. Comply with UL 83 and UL 493.

#### 2.2 NONMETALLIC UNDERGROUND CONDUIT WITH CONDUCTORS, TYPE NUCC

- A. Description: A factory assembly of conductors or cables inside a nonmetallic, smooth wall raceway with a circular cross section.
- B. Applicable Standards:
  - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
  - 2. General Characteristics:
    - a. Reference Standards: UL 1990.

#### 2.3 METAL-CLAD CABLE, TYPE HCF-90 HEALTH CARE FACILITIES

- A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. AFC Cable Systems; Atkore International.
  - 2. Encore Wire Corporation.



3. General Cable; Prysmian Group North America.
4. Southwire Company, LLC.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Comply with UL 1569.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:

1. Single circuit and multicircuit with color-coded conductors.
2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

E. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

F. Ground Conductor: Insulated.

G. Conductor Insulation:

1. Type THHN/THWN-2. Comply with UL 83.

H. Armor: Steel, interlocked.

I. Jacket: PVC applied over armor.

2.4 PHOTOVOLTAIC CABLE, TYPE PV

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. General Cable; Prysmian Group North America.
2. Southwire Company, LLC.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

E. Conductor Insulation: Comply with UL 44 and UL 4703.

## 2.5 MINERAL-INSULATED CABLE, TYPE MI

- A. Description: Solid copper conductors encased in compressed metal oxide with an outer metallic sheath, rated 600 V or less.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. KME America, Inc.
  - 2. PYROTENAX; brand of nVent Electrical plc.
  - 3. Watlow Electric Manufacturing Company.
- C. Standards:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
  - 2. UL 2196 for fire resistance.
  - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B3 for bare annealed copper.
- E. Insulation: Compressed magnesium oxide.
- F. Sheath: Copper.

## 2.6 TRAY CABLE, TYPE TC

- A. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in a nonmetallic jacket.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. General Cable; Prysmian Group North America.
  - 2. Southwire Company, LLC.
- C. Standards:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
  - 2. Comply with UL 1277.
  - 3. Comply with ICEA S-73-532/NEMA WC 57 for Type TC cables used for control, thermocouple extension, and instrumentation.
  - 4. Comply with ICEA S-95-658/NEMA WC 70 for Type TC cables used for power distribution.
  - 5. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
- E. Ground Conductor: Insulated.
- F. Conductor Insulation: Type XHHW-2. Comply with UL 44.

- G. Shield: Metallic.

## 2.7 FIRE-ALARM WIRE AND CABLE

- A. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
  - 1. Allied Wire & Cable Inc.
  - 2. West Penn Wire; brand of Belden, Inc.
- B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- C. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG or size as recommended by system manufacturer.
  - 1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.
- D. Non-Power-Limited Circuits: Solid-copper conductors with 600 V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.
  - 1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
  - 2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
  - 3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with red identifier stripe, NRTL listed for fire-alarm and cable tray installation, plenum rated.

## 2.8 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. 3M Electrical Products.
  - 2. AFC Cable Systems; Atkore International.
  - 3. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
- C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.
- D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
  - 1. Material: Copper.
  - 2. Type: One with standard barrels.
  - 3. Termination: Compression.

## PART 3 - EXECUTION

### 3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders:
  - 1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits:
  - 1. Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. ASD Output Circuits Cable: Extra-flexible stranded for all sizes.
- D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.
- E. PV Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

### 3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN/THWN-2, single conductors in raceway.
- B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- E. Feeders in Cable Tray: Type THHN/THWN-2, single conductors in raceway.
- F. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway or Metal-clad cable, Type HCF-90 Health Care Facilities.
- H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- I. Branch Circuits in Cable Tray: Type THHN/THWN-2, single conductors in raceway or Metal-clad cable, Metal-clad cable, Type HCF-90 Health Care Facilities.
- J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless steel, wire-mesh, strain relief device at terminations to suit application.
- K. PV Circuits, Type USE-2: For PV source circuits rated at 600 V or less.
- L. PV Circuits, Type PV: For PV source circuits rated at 600 V.

### 3.3 INSTALLATION, GENERAL

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

- B. Complete raceway installation between conductor and cable termination points in accordance with Section 260533.13 "Conduits for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- G. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

### 3.4 INSTALLATION OF FIRE-ALARM WIRE AND CABLE

- A. Comply with NFPA 72.
- B. Wiring Method: Install wiring in metal pathway according to Section 270528.29 "Hangers and Supports for Communications Systems."
  - 1. Install plenum cable in environmental airspaces, including plenum ceilings.
  - 2. Fire-alarm circuits and equipment control wiring associated with fire-alarm system must be installed in a dedicated pathway system.
    - a. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.
  - 3. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI, is permitted.
  - 4. Signaling Line Circuits: Power-limited fire-alarm cables must not be installed in the same cable or pathway as signaling line circuits.
- C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.
- E. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.

- F. Risers: Install at least two vertical cable risers to serve the fire-alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent receipt or transmission of signals from other floors or zones.
- G. Wiring to Remote Alarm Transmitting Device: 1 inch (25 mm) conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

### 3.5 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inch (150 mm) of slack.
- D. Comply with requirements in Section 284621.11 "Addressable Fire-Alarm Systems" for connecting, terminating, and identifying wires and cables.

### 3.6 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

### 3.7 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

### 3.8 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

### 3.9 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements:
    - a. All generators.
    - b. All switchboards.
    - c. All transfer switches.
    - d. All distribution type panelboards.

- e. All branch circuit panelboards.
  - f. Portable generator connection cabinet.
2. Perform each of the following visual and electrical tests:
- a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
  - b. Test bolted connections for high resistance using one of the following:
    - 1) A low-resistance ohmmeter.
    - 2) Calibrated torque wrench.
    - 3) Thermographic survey.
  - c. Inspect compression-applied connectors for correct cable match and indentation.
  - d. Inspect for correct identification.
  - e. Inspect cable jacket and condition.
  - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.
  - g. Continuity test on each conductor and cable.
  - h. Uniform resistance of parallel conductors.
3. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
- a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- B. Cables will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports to record the following:
- 1. Procedures used.
  - 2. Results that comply with requirements.
  - 3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION

## SECTION 260523

### CONTROL-VOLTAGE ELECTRICAL POWER CABLES

#### PART 1 - GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. Control cable.
2. Control-circuit conductors.
3. Fire-alarm wire and cable.

###### B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260011 "Facility Performance Requirements for Electrical" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

##### 1.2 ACTION SUBMITTALS

###### A. Product Data:

1. Control cable.
2. Control-circuit conductors.
3. Fire-alarm wire and cable.

##### 1.3 INFORMATIONAL SUBMITTALS

###### A. Source quality-control reports.

###### B. Field quality-control reports.

#### PART 2 - PRODUCTS

##### 2.1 PERFORMANCE REQUIREMENTS

###### A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

###### B. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

1. Flame Travel Distance: 60 inch or less.
2. Peak Optical Smoke Density: 0.5 or less.
3. Average Optical Smoke Density: 0.15 or less.

###### C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.



- D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

## 2.2 CONTROL CABLE

- A. Paired Cable: NFPA 70, Type CMG.
  - 1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
  - 2. PVC insulation.
  - 3. Unshielded.
  - 4. PVC jacket.
  - 5. Flame Resistance: Comply with UL 1685.
- B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
  - 1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
  - 2. PVC insulation.
  - 3. Unshielded.
  - 4. PVC jacket.
  - 5. Flame Resistance: Comply with NFPA 262.

## 2.3 CONTROL-CIRCUIT CONDUCTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Encore Wire Corporation.
  - 2. General Cable; Prysmian Group North America.
  - 3. Service Wire Co.
  - 4. Southwire Company, LLC.
- B. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
- C. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
- D. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
- E. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.
  - 1. Smoke control signaling and control circuits.

## 2.4 FIRE-ALARM WIRE AND CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Allied Wire & Cable Inc.
  - 2. CommScope, Inc.
  - 3. Comtran Corporation.
  - 4. Genesis Cable Products; Honeywell International, Inc.
  - 5. Prysmian Cables and Systems; Prysmian Group North America.

6. Radix Wire.
7. Rockbestos-Suprenant Cable Corp.
8. Superior Essex Inc.; subsidiary of LS Corp.
9. West Penn Wire; brand of Belden, Inc.

- B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- C. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG or size as recommended by system manufacturer.
  1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.
- D. Non-Power-Limited Circuits: Solid-copper conductors with 600 V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.
  1. Control-Voltage Circuits: No. 16 AWG, minimum, in pathway.
  2. Low-Voltage Circuits: No. 12 AWG, minimum, in pathway.
  3. Identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.

## 2.5 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test twisted pair cables according to TIA-568-C.2.
- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Test cables on receipt at Project site.
  1. Test each pair of twisted pair cable for open and short circuits.

### 3.2 INSTALLATION OF RACEWAYS AND BOXES

- A. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" for raceway selection and installation requirements for conduits as supplemented or modified in this Section.
- B. Comply with requirements in Section 260533.23 "Surface Raceways for Electrical Systems" for raceway selection and installation requirements for wireways as supplemented or modified in this Section.
- C. Comply with requirements in Section 260533.16 "Boxes and Covers for Electrical Systems" for raceway selection and installation requirements for boxes as supplemented or modified in this Section.
  1. Outlet boxes must be no smaller than 2 inch wide, 3 inch high, and 2-1/2 inch deep.

2. Outlet boxes for cables must be no smaller than 4 inch square by 2-1/8 inch deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
3. Flexible metal conduit must not be used.

D. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

E. Install manufactured conduit sweeps and long-radius elbows if possible.

### 3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
3. Terminate all conductors; cable must not contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced and must be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
5. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
6. Secure and support cables at intervals not exceeding 30 inch and not more than 6 inch from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lie on removable ceiling tiles.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
15. Ground wire must be copper, and grounding methods must comply with IEEE C2. Demonstrate ground resistance.

C. Installation of Control-Circuit Conductors:

1. Install wiring in raceways.
2. Use insulated spade lugs for wire and cable connection to screw terminals.

D. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment must be as follows:
  - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inch.
  - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inch.
  - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inch.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment must be as follows:
  - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inch.
  - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inch.
  - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inch.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures must be as follows:
  - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
  - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inch.
  - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inch.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inch.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inch.

### 3.4 CONTROL-CIRCUIT CONDUCTORS

#### A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

### 3.5 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping" Chapter.

### 3.6 GROUNDING

- A. For control-voltage wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

### 3.7 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

- B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers must use label stocks, laminating adhesives, and inks complying with UL 969.
- C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire must have a unique tag.

### 3.8 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments and inspect cabling connections to confirm compliance with TIA-568-C.1.
  - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
  - 3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.
    - a. Test instruments must meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide or transfer the data from the instrument to the computer, save as text files, print, and submit.
- C. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION

SECTION 260526

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grounding and bonding conductors.
2. Grounding and bonding clamps.
3. Grounding and bonding bushings.
4. Grounding and bonding hubs.
5. Grounding and bonding connectors.
6. Intersystem bonding bridge grounding connector.
7. Grounding and bonding busbars.
8. Signal reference grids.
9. Grounding (earthing) electrodes.

B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product indicated.

B. Shop Drawings: Plans showing dimensioned locations of grounding features described in "Field Quality Control" Article, including the following:

1. Test wells.
2. Rod electrodes.
3. Ring electrodes.
4. Grounding arrangements and connections for separately derived systems.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. In addition to items specified in 260000 "General Requirements for Electrical" include the following:
  - a. Plans showing locations of grounding features described in "Field Quality Control" Article, including the following:

- 1) Test wells.
- 2) Rod electrodes.
- 3) Ring electrodes.
- 4) Grounding arrangements and connections for separately derived systems.

## PART 2 - PRODUCTS

### 2.1 GROUNDING AND BONDING CONDUCTORS

#### A. Equipment Grounding Conductor:

1. General Characteristics: 600 V, THHN/THWN-2, copper wire or cable, green color, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

#### B. Isolated Equipment Grounding Conductor:

1. General Characteristics: 600 V, THHN/THWN-2, copper wire or cable, green color with one or more yellow stripes, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

#### C. ASTM - Bare Copper Grounding and Bonding Conductor:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ERICO; brand of nVent Electrical plc.
  - b. Harger Lightning & Grounding; business of Harger, Inc.
2. Referenced Standards: Complying with one or more of the following:
  - a. Soft or Annealed Copper Wire: ASTM B3
  - b. Concentric-Lay Stranded Copper Conductor: ASTM B8.
  - c. Tin-Coated Soft or Annealed Copper Wire: ASTM B33.
  - d. 19-Wire Combination Unilay-Stranded Copper Conductor: ASTM B787/B787M.

### 2.2 GROUNDING AND BONDING CLAMPS

#### A. Description: Clamps suitable for attachment of grounding and bonding conductors to grounding electrodes, pipes, tubing, and rebar. Grounding and bonding clamps specified in this article are also suitable for use with communications applications; see Section 270526 "Grounding and Bonding for Communications Systems," for selection and installation guidelines.

#### B. Source Limitations: Obtain products from single manufacturer.

#### C. Performance Criteria:

1. Regulatory Requirements:
  - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria:
  - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

- b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
- D. UL KDER and KDSH - Hex-Fitting-Type Pipe and Rod Grounding and Bonding Clamp:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Cooper B-line; brand of Eaton, Electrical Sector.
    - b. Crouse-Hinds; brand of Eaton, Electrical Sector.
    - c. ERICO; brand of nVent Electrical plc.
    - d. Panduit Corp.
    - e. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - 2. General Characteristics:
    - a. Two pieces with zinc-plated bolts.
    - b. Clamp Material: Die-cast zinc alloy.
    - c. Listed for outdoor use.
- E. UL KDER and KDSH - U-Bolt-Type Pipe and Rod Grounding and Bonding Clamp:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Cooper B-line; brand of Eaton, Electrical Sector.
    - b. Crouse-Hinds; brand of Eaton, Electrical Sector.
    - c. ERICO; brand of nVent Electrical plc.
    - d. Panduit Corp.
    - e. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - 2. General Characteristics:
    - a. Clamp Material: Aluminum.
    - b. Listed for outdoor use.
- F. UL KDER and KDSH - Strap-Type Pipe and Rod Grounding and Bonding Clamp:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Crouse-Hinds; brand of Eaton, Electrical Sector.
    - b. ERICO; brand of nVent Electrical plc.
    - c. Panduit Corp.
  - 2. General Characteristics:
    - a. Clamp Material: Tinned copper.
    - b. Listed for outdoor use.
- G. UL KDER - Beam Grounding and Bonding Clamp:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:



- a. Anderson; brand of Hubbell Utility Solutions; Hubbell Incorporated.
    - b. Panduit Corp.
    - c. Penn-Union Corp.; subsidiary of Nesco, Inc.
  - 2. General Characteristics: Mechanical-type, terminal, ground wire access from four directions; with dual, tin-plated or silicon bronze bolts.
- H. UL KDER - Exothermically Welded Connection:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated.
    - b. Crouse-Hinds; brand of Eaton, Electrical Sector.
    - c. ERICO; brand of nVent Electrical plc.
  - 2. General Characteristics: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

### 2.3 GROUNDING AND BONDING BUSHINGS

- A. Description: Bonding bushings connect conduit fittings, tubing fittings, threaded metal conduit, and unthreaded metal conduit to metal boxes and equipment enclosures and have one or more bonding screws intended to provide electrical continuity between bushing and enclosure. Grounding bushings have provision for connection of bonding or grounding conductor and may or may not also have bonding screws.
- B. Performance Criteria:
  - 1. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  - 2. Listing Criteria:
    - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
- C. UL KDER - Bonding Bushing:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arlington Industries, Inc.
    - b. Crouse-Hinds; brand of Eaton, Electrical Sector.
    - c. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - 2. General Characteristics: Threaded bushing with insulated throat.
- D. UL KDER - Grounding Bushing:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Arlington Industries, Inc.
  - b. Crouse-Hinds; brand of Eaton, Electrical Sector.
  - c. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
2. General Characteristics: Threaded bushing with insulated throat and mechanical-type wire terminal.

## 2.4 GROUNDING AND BONDING HUBS

- A. Description: Hubs with certified grounding or bonding locknut.
- B. Source Limitations: Obtain products from single manufacturer.
- C. Performance Criteria:
  1. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  2. Listing Criteria:
    - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

## 2.5 GROUNDING AND BONDING CONNECTORS

- A. Source Limitations: Obtain products from single manufacturer.
- B. Performance Criteria:
  1. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  2. Listing Criteria:
    - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
    - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

## 2.6 INTERSYSTEM BONDING BRIDGE GROUNDING CONNECTORS

- A. Description: Devices that provide means for connecting communications systems grounding and bonding conductors at service equipment or at disconnecting means for buildings or structures.
- B. Performance Criteria:
  1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  - 2. Listing Criteria:
    - a. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
- C. UL KDSH - One-Piece Intersystem Bonding Bridge Grounding Connector:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Galvan Industries, Inc.; Electrical Products Division, LLC.
    - b. Madison Electric Products; business of Southwire Company, LLC.
  - 2. General Characteristics: Zinc-alloy one-piece construction; six terminating points; gangable.
- D. UL KDSH - Two-Piece Intersystem Bonding Bridge Grounding Connector:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - b. Crouse-Hinds; brand of Eaton, Electrical Sector.
    - c. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - 2. General Characteristics: Copper body and polycarbonate cover; four terminating points.

## 2.7 GROUNDING AND BONDING BUSBARS

- A. Description: Miscellaneous grounding and bonding device that serves as common connection for multiple grounding and bonding conductors.
- B. Source Limitations: Obtain products from single manufacturer.
- C. Performance Criteria:
  - 1. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
  - 2. Listing Criteria:
    - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

## 2.8 GROUNDING (EARTHING) ELECTRODES

- A. Description: Grounding electrodes include rod electrodes, ring electrodes, metal underground water pipes, metal building frames, concrete-encased electrodes, and pipe and plate electrodes.

- B. Source Limitations: Obtain products from single manufacturer.
- C. Performance Criteria:
  - 1. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  - 2. Listing Criteria:
    - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
- D. UL KDER - Rod Electrode:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ABB, Electrification Business.
    - b. Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated.
    - c. ERICO; brand of nVent Electrical plc.
    - d. Galvan Industries, Inc.; Electrical Products Division, LLC.
    - e. Harger Lightning & Grounding; business of Harger, Inc.
    - f. allG Fabrication (formerly ALT).
  - 2. General Characteristics: Copper-clad; 3/4 inch by 10 ft.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.
- B. Inspect test results of grounding system measured at point of electrical service equipment connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of electrical service equipment only after unsatisfactory conditions have been corrected.

#### 3.2 SELECTION OF BUSBARS

- A. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
  - 1. Install bus horizontally, on insulated spacers 2 inch minimum from wall, 96 inches above finished floor unless otherwise indicated.

### 3.3 SELECTION OF GROUNDING AND BONDING CONDUCTORS

- A. Conductors: Install solid conductor for 8 AWG and smaller, and stranded conductors for 6 AWG and larger unless otherwise indicated.
- B. Custom-Length Insulated Equipment Bonding Jumpers: 6 AWG, 19-strand, Type THHN.
- C. Bonding Cable: 28 kcmil, 14 strands of 17 AWG conductor, 1/4 inch in diameter.
- D. Bonding Conductor: 4 AWG or 6 AWG, stranded conductor.
- E. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.
- F. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.
- G. Underground Grounding Conductors: Install bare tinned-copper conductor, 4/0 AWG minimum.
  - 1. Bury at least 30 inch below grade.

### 3.4 SELECTION OF CONNECTORS

- A. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
  - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
  - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
  - 4. Connections to Structural Steel: Welded connectors.

### 3.5 INSTALLATION

- A. Comply with manufacturer's published instructions.
- B. Special Techniques:
  - 1. Conductors:
    - a. Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
  - 2. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
    - a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
    - b. Make connections with clean, bare metal at points of contact.
    - c. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
    - d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.

- e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
  - f. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
    - 1) Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate adjacent parts.
    - 2) Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
    - 3) Use exothermic-welded connectors for outdoor locations; if disconnect-type connection is required, use bolted clamp.
  - g. Grounding and Bonding for Piping:
    - 1) Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use bolted clamp connector or bolt lug-type connector to pipe flange by using one of lug bolts of flange. Where dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
    - 2) Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with bolted connector.
    - 3) Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
  - h. Grounding for Steel Building Structure: Install driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 ft apart.
3. Electrodes:
- a. Ground Rods: Drive rods until tops are 2 inch below finished floor or final grade unless otherwise indicated.
    - 1) Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
    - 2) Use exothermic welds for below-grade connections.
4. Grounding at Service:
- a. Equipment grounding conductors and grounding electrode conductors must be connected to ground bus. Install main bonding jumper between neutral and ground buses.
5. Grounding Separately Derived Systems:
- a. Generator: Install grounding electrode(s) at generator location. Electrode must be connected to equipment grounding conductor and to frame of generator.
6. Equipment Grounding:

- a. Install insulated equipment grounding conductors with all feeders and all branch circuits.
- b. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
  - 1) Feeders and branch circuits.
  - 2) Lighting circuits.
  - 3) Receptacle circuits.
  - 4) Single-phase motor and appliance branch circuits.
  - 5) Three-phase motor and appliance branch circuits.
  - 6) Flexible raceway runs.
  - 7) Armored and metal-clad cable runs.
- c. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- d. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- e. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

### 3.6 FIELD QUALITY CONTROL

#### A. Tests and Inspections:

- 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
- 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench in accordance with manufacturer's published instructions.
- 3. Test completed grounding system at each location where maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before conductors are connected.
  - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
  - b. Perform tests by fall-of-potential method in accordance with IEEE Std 81.
  - c. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

#### B. Nonconforming Work:

- 1. Grounding system will be considered defective if it does not pass tests and inspections.
- 2. Remove and replace defective components and retest.

#### C. Collect, assemble, and submit test and inspection reports.

- 1. Report measured ground resistances that exceed the following values:

- a. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10  $\Omega$ .
- b. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5  $\Omega$ .
- c. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3  $\Omega$ .

### 3.7 PROTECTION

- A. After installation, protect grounding and bonding cables and equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION



## SECTION 260529

### HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:

- 1. Support, anchorage, and attachment components.
  - 2. Fabricated metal equipment support assemblies.

- B. Related Requirements:

- 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.

##### 1.3 ACTION SUBMITTALS

- A. Product Data:

- 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
    - a. Slotted support systems, hardware, and accessories.
    - b. Clamps.
    - c. Hangers.
    - d. Sockets.
    - e. Eye nuts.
    - f. Fasteners.
    - g. Anchors.
    - h. Saddles.
    - i. Brackets.
  - 2. Include rated capacities and furnished specialties and accessories.

- B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.

- 1. Hangers. Include product data for components.
  - 2. Slotted support systems.
  - 3. Equipment supports.
  - 4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittals: For hangers and supports for electrical systems.

1. Include design calculations and details of hangers.
2. Include design calculations for seismic restraints.

#### 1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified structural professional engineer to design hanger and support system.
- B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame Rating: Class 1.
  2. Self-extinguishing according to ASTM D635.

#### 2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32 inch diameter holes at a maximum of 8 inch on center in at least one surface.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ABB, Electrification Business.
    - b. Allied Tube & Conduit; Atkore International.
    - c. Cooper B-line; brand of Eaton, Electrical Sector.
    - d. Unistrut; Atkore International.
  2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
  3. Material for Channel, Fittings, and Accessories: Galvanized steel.
  4. Channel Width: Selected for applicable load criteria.
  5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
  7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
  8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum 13/32 inch diameter holes at a maximum of 8 inch on center, in at least one surface.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit; Atkore International.
    - b. Cooper B-line; brand of Eaton, Electrical Sector.

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
  3. Channel Width: Selected for applicable load criteria.
  4. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
  5. Fitting and Accessory Materials: Same as those for channels and angles, except metal items may be stainless steel.
  6. Rated Strength: Selected to suit applicable load criteria.
  7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must be made of malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Hilti, Inc.
      - 2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
      - 3) MKT Fastening, LLC.
      - 4) Simpson Strong-Tie Co., Inc.
  2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Cooper B-line; brand of Eaton, Electrical Sector.
      - 2) Empire Industries, Inc.
      - 3) Hilti, Inc.
      - 4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
      - 5) MKT Fastening, LLC.
  3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
  4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
6. Toggle Bolts: All steel springhead type.
7. Hanger Rods: Threaded steel.

### 2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

## PART 3 - EXECUTION

### 3.1 SELECTION

- A. Comply with the following standards for selection and installation of hangers and supports, except where requirements on Drawings or in this Section are stricter:
  1. NECA NEIS 101
  2. NECA NEIS 105.
- B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for raceways specified in Section 260533.13 "Conduits for Electrical Systems."
- D. Comply with requirements for boxes specified in Section 260533.16 "Boxes and Covers for Electrical Systems."
- E. Provide vibration and seismic controls with hangers and supports in accordance with requirements specified in "Section 260548 "Vibration and Seismic Controls for Electrical Systems." and "Section 260548.16 "Seismic Controls for Electrical Systems."
- F. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERMC as required by NFPA 70. Minimum rod size must be 1/4 inch in diameter.
- G. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- H. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2 inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

### 3.2 INSTALLATION OF SUPPORTS

- A. Comply with NECA NEIS 101 for installation requirements except as specified in this article.

- B. Raceway Support Methods: In addition to methods described in NECA NEIS 1, EMT, IMC, and ERMC may be supported by openings through structure members, in accordance with NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination must be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  1. To Wood: Fasten with lag screws or through bolts.
  2. To New Concrete: Bolt to concrete inserts.
  3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  4. To Existing Concrete: Expansion anchor fasteners.
  5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69, or Spring-tension clamps.
  6. To Light Steel: Sheet metal screws.
  7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

### 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M. Submit welding certificates.

### 3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inch larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000 psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base as follows:
  1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

### 3.5 PAINTING

#### A. Touchup:

1. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - a. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
2. Comply with requirements in Section 099113 "Exterior Painting", Section 099123 "Interior Painting", and Section 099600 "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

- #### B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION

## SECTION 260533.13

### CONDUITS FOR ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

###### A. Section Includes:

1. Type EMT-S duct raceways and elbows.
2. Type ENT duct raceways and fittings.
3. Type ERMC-S duct raceways, elbows, couplings, and nipples.
4. Type FMC-S duct raceways.
5. Type IMC duct raceways.
6. Type LFMC duct raceways.
7. Type LFNC duct raceways.
8. Type PVC duct raceways and fittings.
9. Fittings for conduit, tubing, and cable.
10. Electrically conductive corrosion-resistant compounds for threaded conduit.
11. Solvent cements.

###### B. Products Installed, but Not Furnished, under This Section:

1. See Section 260553 "Identification for Electrical Systems" for electrical equipment labels.

###### C. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.
2. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" for nonmetallic underground conduit with conductors (Type NUCC).
3. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior duct banks, manholes, and underground utility construction.

##### 1.3 DEFINITIONS

- A. Conduit: A structure containing one or more duct raceways.
- B. Duct Raceway: A single enclosed raceway for conductors or cable.
- C. Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.

##### 1.4 ACTION SUBMITTALS

###### A. Product Data:

1. Type EMT-S duct raceways and elbows.
2. Type ENT duct raceways and fittings.
3. Type ERMC-S duct raceways, elbows, couplings, and nipples.
4. Type FMC-S duct raceways.
5. Type IMC duct raceways.
6. Type LFMC duct raceways.
7. Type LFNC duct raceways.
8. Type PVC duct raceways and fittings.
9. Fittings for conduit, tubing, and cable.
10. Electrically conductive corrosion-resistant compounds for threaded conduit.
11. Solvent cements.

## 1.5 INFORMATIONAL SUBMITTALS

### A. Manufacturers' Published Instructions:

1. Type EMT-S duct raceways and elbows.
2. Type ENT duct raceways and fittings.
3. Type ERMC-S duct raceways, elbows, couplings, and nipples.
4. Type FMC-S duct raceways.
5. Type IMC duct raceways.
6. Type LFMC duct raceways.
7. Type LFNC duct raceways.
8. Type PVC duct raceways and fittings.
9. Fittings for conduit, tubing, and cable.
10. Electrically conductive corrosion-resistant compounds for threaded conduit.
11. Solvent cements.

## PART 2 - PRODUCTS

### 2.1 TYPE EMT-S DUCT RACEWAYS AND ELBOWS

#### A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria: UL CCN FJMX; including UL 797.

#### B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

#### C. UL FJMX - Steel Electrical Metal Tubing (EMT-S) and Elbows:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Allied Tube & Conduit; Atkore International.
  - b. Republic Conduit; Nucor Corporation, Nucor Tubular Products.
  - c. Western Tube; Zekelman Industries.



- d. Wheatland Tube; Zekelman Industries.
- 2. Material: Steel.
- 3. Options:
  - a. Exterior Coating: Zinc.
  - b. Interior Coating: Zinc with organic top coating.
  - c. Minimum Trade Size: Metric designator 21 (trade size 3/4).

## 2.2 TYPE ENT DUCT RACEWAYS AND FITTINGS

### A. Performance Criteria:

- 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
- 2. Listing Criteria: UL CCN FKHU; including UL 1653.

### B. Source Quality Control:

- 1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
- 2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

### C. UL FKHU - Electrical Nonmetallic Tubing (ENT) and Fittings:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Business.
  - b. Cantex Inc.
  - c. JM Eagle.
- 2. Options:
  - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
  - b. Fittings:
    - 1) Mechanically Attached Fittings: UL 1653.
    - 2) Solvent-Attached Fittings: UL 651.

## 2.3 TYPE ERMC-S DUCT RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

### A. Performance Criteria:

- 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
- 2. Listing Criteria: UL CCN DYIX; including UL 6.

### B. Source Quality Control:

- 1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.

2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.
- C. UL DYIX - Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit; Atkore International.
    - b. Crouse-Hinds; brand of Eaton, Electrical Sector.
    - c. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - d. Republic Conduit; Nucor Corporation, Nucor Tubular Products.
    - e. Western Tube; Zekelman Industries.
    - f. Wheatland Tube; Zekelman Industries.
  2. Exterior Coating: Zinc.
  3. Options:
    - a. Interior Coating: Zinc with organic top coating.
    - b. Minimum Trade Size: Metric designator 21 (trade size 3/4).
- D. UL DYIX - PVC-Coated-Steel Electrical Rigid Metal Conduit (ERMC-S-PVC), Elbows, Couplings, and Nipples:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ABB, Electrification Business.
    - b. Calbond; Atkore International.
    - c. Plasti-Bond; Robroy Industries.
  2. Options:
    - a. Exterior Coating: PVC complying with NEMA RN 1.
    - b. Interior Coating: Zinc with organic top coating.
    - c. Minimum Trade Size: Metric designator 21 (trade size 3/4).
    - d. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

## 2.4 TYPE FMC-S DUCT RACEWAYS

- A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  2. Listing Criteria: UL CCN DXUZ; including UL 1.
- B. Source Quality Control:
1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
  2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

- C. UL DXUZ - Steel Flexible Metal Conduit (FMC-S):
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anaconda Sealtite; Anamet Electrical, Inc.
    - b. Electri-Flex Company.
  - 2. Material: Steel.
  - 3. Options:
    - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

## 2.5 TYPE IMC DUCT RACEWAYS

- A. Performance Criteria:
  - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  - 2. Listing Criteria: UL CCN DYBY; including UL 1242.
- B. Source Quality Control:
  - 1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
  - 2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.
- C. UL DYBY - Steel Intermediate Metal Conduit (IMC):
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit; Atkore International.
    - b. Republic Conduit; Nucor Corporation, Nucor Tubular Products.
    - c. Western Tube; Zekelman Industries.
    - d. Wheatland Tube; Zekelman Industries.
  - 2. Options:
    - a. Exterior Coating: Zinc.
    - b. Interior Coating: Zinc with organic top coating.
    - c. Minimum Trade Size: Metric designator 21 (trade size 3/4).

## 2.6 TYPE LFMC DUCT RACEWAYS

- A. Performance Criteria:
  - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  - 2. Listing Criteria: UL CCN DXHR; including UL 360.
- B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DXHR - Steel Liquidtight Flexible Metal Conduit (LFMC-S):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Anaconda Sealtite; Anamet Electrical, Inc.
  - b. Anaconda Sealtite; Anamet Electrical, Inc.
  - c. Anaconda Sealtite; Anamet Electrical, Inc.
  - d. Electri-Flex Company.
2. Material: Steel.
3. Options:
  - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

2.7 TYPE LFNC DUCT RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria: UL CCN DXOQ; including UL 1660.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DXOQ - Layered (Type A) Liquidtight Flexible Nonmetallic Conduit (LFNC-A):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. AFC Cable Systems; Atkore International.
  - b. Electri-Flex Company.
2. Additional Criteria: Type A conduit with smooth seamless inner core and cover bonded together with one or more reinforcement layers between core and cover.
3. Options:
  - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
  - b. Markings: 80 deg C dry and Sunlight resistant.

D. UL DXOQ - Integral (Type B) Liquidtight Flexible Nonmetallic Conduit (LFNC-B):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Cambridge Resources.
  - b. Electri-Flex Company.
2. Additional Criteria: Type B conduit with smooth inner surface with integral reinforcement within conduit wall.
  3. Options:
    - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
    - b. Markings: 80 deg C dry and Sunlight resistant.

E. UL DXOQ - Corrugated (Type C) Liquidtight Flexible Nonmetallic Conduit (LFNC-C):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Business.
  - b. HellermannTyton.
2. Additional Criteria: Type C conduit with corrugated internal and external surfaces without integral reinforcement within conduit wall.
3. Options:
  - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
  - b. Markings: 80 deg C dry and Sunlight resistant.

## 2.8 TYPE PVC DUCT RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria: UL CCN DZYR; including UL 651.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DZYR - Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Business.
  - b. JM Eagle.
2. Dimensional Specifications: Schedule 40.
3. Options:
  - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
  - b. Markings: For use with maximum 90 deg C wire.

- D. UL DZYZR - Schedule 80 Rigid PVC Conduit (PVC-80) and Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ABB, Electrification Business.
    - b. JM Eagle.
  2. Dimensional Specifications: Schedule 80.
  3. Options:
    - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
    - b. Markings: For use with maximum 90 deg C wire.
- E. UL DZYZR - Type A Rigid PVC Concrete-Encased Conduit (PVC-A) and Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Southern Pipe, Inc.
  2. Dimensional Specifications: Type A.
  3. Options:
    - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
- F. UL DZYZR - Type EB Rigid PVC Concrete-Encased Underground Conduit (PVC-EB) and Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. JM Eagle.
    - b. Southern Pipe, Inc.
  2. Dimensional Specifications: Type EB.
  3. Options:
    - a. Minimum Trade Size: Metric designator 53 (trade size 2).

## 2.9 FITTINGS FOR CONDUIT, TUBING, AND CABLE

- A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
- B. Source Quality Control:
1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
  2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DWTT - Fittings for Type IMC and Type PVC Duct Raceways:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Business.
  - b. Appleton; Emerson Electric Co., Automation Solutions.
  - c. Crouse-Hinds; brand of Eaton, Electrical Sector.
  - d. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
  - e. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - f. Southwire Company, LLC.
2. Listing Criteria: UL CCN DWTT; including UL 514B.
3. Options:
  - a. Material: Steel.
  - b. Coupling Method: Setscrew coupling. Setscrew couplings with only single screw per conduit are unacceptable.
  - c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

D. UL FKAV - Fittings for Type EMT Duct Raceways:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Allied Tube & Conduit; Atkore International.
  - b. Appleton; Emerson Electric Co., Automation Solutions.
  - c. Crouse-Hinds; brand of Eaton, Electrical Sector.
  - d. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
  - e. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - f. Southwire Company, LLC.
2. Listing Criteria: UL CCN FKAV; including UL 514B.
3. Options:
  - a. Material: Steel.
  - b. Coupling Method: Setscrew coupling. Setscrew couplings with only single screw per conduit are unacceptable.
  - c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

E. UL ILNR - Fittings for Type FMC Duct Raceways:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Fittings Corp. (AMFICO).
  - b. Liquid Tight Connector Co.
  - c. Southwire Company, LLC.
2. Listing Criteria: UL CCN ILNR; including UL 514B.

F. UL DXAS - Fittings for Type LFMC and Type LFNC Duct Raceways:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Liquid Tight Connector Co.
2. Listing Criteria: UL CCN DXAS; including UL 514B.

## 2.10 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT

### A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria: UL CCN FOIZ; including UL Subject 2419.

### B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

### C. UL FOIZ - Electrically Conductive Corrosion-Resistant Compound for Threaded Conduit:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. ABB, Electrification Business.

## 2.11 SOLVENT CEMENTS

### A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria: UL CCN DWTT; including UL 514B.

### B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

### C. UL DWTT - Solvent Cements for Type PVC Duct Raceways and Fittings:



## PART 3 - EXECUTION

### 3.1 SELECTION OF CONDUITS FOR ELECTRICAL SYSTEMS

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of duct raceways. Consult Architect for resolution of conflicting requirements.
- B. Outdoors:
1. Exposed and Subject to Severe Physical Damage: ERM C.
  2. Exposed and Subject to Physical Damage: ERM C.
    - a. Locations less than 2.5 m (8 ft) above finished floor.
  3. Exposed and Not Subject to Physical Damage: ERM C.
  4. Concealed Aboveground: ERM C.
  5. Direct Buried: PVC-40 or as indicated on drawings.
  6. Concrete Encased Not in Trench: PVC-40 or as indicated on drawings.
  7. Concrete Encased in Trench: PVC-40 or as indicated on drawings.
  8. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFNC-A or LFNC-B in short lengths (minimum eighteen (18) inches, maximum length six (6) feet).
- C. Indoors:
1. Exposed and Subject to Severe Physical Damage: ERM C. Locations include the following:
    - a. Loading docks.
    - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    - c. Mechanical rooms.
    - d. Gymnasiums.
  2. Exposed and Subject to Physical Damage: ERM C. Locations include the following:
    - a. Locations less than 2.5 m (8 ft) above finished floor.
    - b. Stub-ups to above suspended ceilings.
  3. Exposed and Not Subject to Physical Damage: EMT.
  4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
  5. Damp or Wet Locations: ERM C.
  6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use Liquidtight Flexible Metallic Conduit in damp or wet locations and in Mechanical Equipment Rooms. Flexible conduit shall be installed in short lengths (minimum eighteen (18) inches, maximum length six (6) feet).
- D. Duct Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.
1. ERM C and IMC: Provide threaded-type fittings unless otherwise indicated.

### 3.2 INSTALLATION OF CONDUITS FOR ELECTRICAL SYSTEMS

- A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Type EMT-S: Article 358 of NFPA 70 and NECA NEIS 101.
2. Type ENT: Article 362 of NFPA 70 and NECA NEIS 102.
3. Type ERMC-S: Article 344 of NFPA 70 and NECA NEIS 101.
4. Type FMC-S: Article 348 of NFPA 70 and NECA NEIS 101.
5. Type FMT: Article 360 of NFPA 70 and NECA NEIS 101.
6. Type IMC: Article 342 of NFPA 70 and NECA NEIS 101.
7. Type LFMC: Article 350 of NFPA 70 and NECA NEIS 101.
8. Type LFNC: Article 342 of NFPA 70 and NECA NEIS 111.
9. Type PVC: Article 356 of NFPA 70 and NECA NEIS 111.
10. Expansion Fittings: NEMA FB 2.40.
11. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. General Requirements for Installation of Duct Raceways:

- a. Complete duct raceway installation before starting conductor installation.
- b. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of 2 ft above finished floor.
- c. Install no more than equivalent of three 90-degree bends in conduit run except for control wiring conduits, for which no more than equivalent of two 90-degree fewer bends are permitted. Support within 12 inch of changes in direction.
- d. Make bends in duct raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
- e. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- f. Support conduit within 12 inch of enclosures to which attached.
- g. Install duct sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed duct raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install duct sealing fittings in accordance with NFPA 70.
- h. Install devices to seal duct raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of duct raceways at the following points:
  - 1) Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  - 2) Where an underground service duct raceway enters a building or structure.
  - 3) Conduit extending from interior to exterior of building.
  - 4) Conduit extending into pressurized duct raceway and equipment.
  - 5) Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
  - 6) Where otherwise required by NFPA 70.
- i. Do not install conduits within 2 inch of the bottom side of a metal deck roof.
- j. Keep duct raceways at least 6 inch away from parallel runs of flues and steam or hot-water pipes. Install horizontal duct raceway runs above water and steam piping.

- k. Cut conduit perpendicular to the length. For conduits metric designator 53 (trade size 2) and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
  - l. Install pull wires in empty duct raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inch of slack at both ends of pull wire. Cap underground duct raceways designated as spare above grade alongside duct raceways in use.
  - m. Install duct raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.
    - 1) Termination fittings with shoulders do not require two locknuts.
  - n. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to metric designator 35 (trade size 1-1/4) and insulated throat metal bushings on metric designator 41 (trade size 1-1/2) and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
2. Types ERM and IMC:
    - a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of duct raceway and fittings before making up joints. Follow compound manufacturer's published instructions.
  3. Type ERM-S-PVC:
    - a. Follow manufacturer's installation instructions for clamping, cutting, threading, bending, and assembly.
    - b. Provide PVC-coated sealing locknut for exposed male threads transitioning into female NPT threads that do not have sealing sleeves, including transitions from PVC couplings/female adapters to Type ERM-S-PVC elbows in direct-burial applications. PVC-coated sealing locknuts must not be used in place of conduit hub. PVC-coated sealing locknut must cover exposed threads on Type ERM-S-PVC duct raceway.
    - c. Coat field-cut threads on PVC-coated duct raceway with manufacturer-approved corrosion-preventing conductive compound prior to assembly.
  4. Types FMC, LFMC, and LFNC:
    - a. Provide a maximum of 72 inch of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
  5. Type PVC:
    - a. Do not install Type PVC conduit where ambient temperature exceeds 122 deg F. Conductor ratings must be limited to 75 deg C except where installed in a trench outside buildings with concrete encasement, where 90 deg C conductors are permitted.
    - b. Comply with manufacturer's published instructions for solvent welding and fittings.
  6. Duct Raceways Embedded in Slabs:

- a. Run duct raceways larger than metric designator 27 (trade size 1) below concrete slab.
  - b. Arrange duct raceways to cross building expansion joints with expansion fittings at right angles to the joint.
  - c. Arrange duct raceways to ensure that each is surrounded by minimum of 2 inch of concrete without voids.
  - d. Do not embed threadless fittings in concrete unless locations have been specifically approved by Architect.
  - e. Change from ENT to ERM C before rising above floor.
7. Stub-ups to Above Recessed Ceilings:
- a. Provide EMT, IMC, or ERM C for duct raceways.
  - b. Provide a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
8. Duct Raceway Terminations at Locations Subject to Moisture or Vibration:
- a. Provide insulating bushings to protect conductors, including conductors smaller than 4 AWG. Install insulated throat metal grounding bushings on service conduits.
9. Duct Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.
- a. ERM C-S-PVC: Provide only fittings listed for use with this type of conduit. Patch and seal joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Provide sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
  - b. EMT: Provide setscrew fittings. Comply with NEMA FB 2.10.
  - c. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.
10. Expansion-Joint Fittings:
- a. Install in runs of aboveground PVC that are located where environmental temperature change may exceed 30 deg F and that have straight-run length that exceeds 25 ft. Install in runs of aboveground ERM C and EMT conduit that are located where environmental temperature change may exceed 100 deg F and that have straight-run length that exceeds 100 ft.
  - b. Install type and quantity of fittings that accommodate temperature change listed for the following locations:
    - 1) Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    - 2) Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    - 3) Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    - 4) Attics: 135 deg F temperature change.
  - c. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.

- d. Install expansion fittings at locations where conduits cross building or structure expansion joints.
  - e. Install expansion-joint fitting with position, mounting, and piston setting selected in accordance with manufacturer's published instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
11. Duct Raceways Penetrating Rooms or Walls with Acoustical Requirements: Seal duct raceway openings on both sides of rooms or walls with acoustically rated putty or firestopping.
12. Identification: Provide labels for conduit assemblies, duct raceways, and associated electrical equipment.
- a. Provide warning signs.

### 3.3 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
- 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

## SECTION 260533.16

### BOXES AND COVERS FOR ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

###### A. Section Includes:

1. Metallic outlet boxes, device boxes, rings, and covers.
2. Nonmetallic outlet boxes, device boxes, rings, and covers.
3. Junction boxes and pull boxes.
4. Cover plates for device boxes.
5. Hoods for outlet boxes.

###### B. Products Installed, but Not Furnished, under This Section:

1. See Section 260553 "Identification for Electrical Systems" for electrical equipment labels.

###### C. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.

##### 1.3 ACTION SUBMITTALS

###### A. Product Data:

1. Metallic outlet boxes, device boxes, rings, and covers.
2. Nonmetallic outlet boxes, device boxes, rings, and covers.
3. Junction boxes and pull boxes.
4. Cover plates for device boxes.
5. Hoods for outlet boxes.

###### B. Shop Drawings:

1. Shop drawings for floor boxes.

##### 1.4 INFORMATIONAL SUBMITTALS

###### A. Manufacturers' Published Instructions:

1. Metallic outlet boxes, device boxes, rings, and covers.
2. Junction boxes and pull boxes.
3. Cover plates for device boxes.
4. Hoods for outlet boxes.

## PART 2 - PRODUCTS

### 2.1 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

#### A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria: UL CCN QCIT; including UL 514A.

#### B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.
3. Samples:
  - a. Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
  - b. Raised Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
  - c. Recessed Access-Floor Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.
  - d. Concrete Box Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors and flooring inserts for each type of floor box.

#### C. UL QCIT - Metallic Outlet Boxes and Covers:

1. Description: Box having pryout openings, knockouts, threaded entries, or hubs in either the sides of the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Appleton; Emerson Electric Co., Automation Solutions.
  - b. Crouse-Hinds; brand of Eaton, Electrical Sector.
  - c. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - d. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - e. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - f. Pass & Seymour; Legrand North America, LLC.
  - g. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - h. Spring City Electrical Manufacturing Company.
  - i. Wiremold; Legrand North America, LLC.
3. Options:
  - a. Material: Sheet steel.

- b. Sheet Metal Depth: Minimum 3.5 inch.
- c. Luminaire Outlet Boxes and Covers: Nonadjustable, listed and labeled for attachment of luminaire weighing more than 50 lb and marked with maximum allowable weight.
- d. Paddle Fan Outlet Boxes and Covers: Nonadjustable, designed for attachment of paddle fan weighing up to 70 lb.

D. UL QCIT - Metallic Conduit Bodies:

- 1. Description: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
- 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Appleton; Emerson Electric Co., Automation Solutions.
  - b. Crouse-Hinds; brand of Eaton, Electrical Sector.
  - c. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - d. Pass & Seymour; Legrand North America, LLC.
  - e. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.

E. UL QCIT - Metallic Device Boxes :

- 1. Description: Box with provisions for mounting wiring device directly to box.
- 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Appleton; Emerson Electric Co., Automation Solutions.
  - b. Crouse-Hinds; brand of Eaton, Electrical Sector.
  - c. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - d. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - e. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - f. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
- 3. Options:
  - a. Material: Sheet steel.
  - b. Sheet Metal Depth: minimum 3.5 inch.

F. UL QCIT - Metallic Extension Rings:

- 1. Description: Ring intended to extend sides of outlet box or device box to increase box depth, volume, or both.
- 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Appleton; Emerson Electric Co., Automation Solutions.
  - b. Crouse-Hinds; brand of Eaton, Electrical Sector.
  - c. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - d. Pass & Seymour; Legrand North America, LLC.
  - e. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.



G. UL QCIT - Metallic Floor Boxes and Floor Box Covers:

1. Description: Box mounted in floor with floor box cover and other components to complete floor box enclosure.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - c. Wiremold; Legrand North America, LLC.

H. UL QCIT - Metallic Raised-Floor Boxes and Floor Box Covers:

1. Description: Box mounted in raised-floor with floor box cover and other components to complete floor box enclosure.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - b. Wiremold; Legrand North America, LLC.

I. UL QCIT - Metallic Recessed Access-Floor Boxes and Recessed Floor Box Covers:

1. Description: Floor box with provisions for mounting wiring devices below floor surface and floor box cover with provisions for passage of cords to recessed wiring devices mounted within floor box.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - c. Wiremold; Legrand North America, LLC.

J. UL QCIT - Metallic Concrete Boxes and Covers:

1. Description: Box intended for use in poured concrete.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Crouse-Hinds; brand of Eaton, Electrical Sector.
  - b. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - c. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - d. Wiremold; Legrand North America, LLC.

2.2 JUNCTION BOXES AND PULL BOXES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. Listing Criteria: UL CCN BGUZ; including UL 50 and UL 50E.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL BGUZ - Indoor Sheet Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Adalet.
  - b. Appleton; Emerson Electric Co., Automation Solutions.
  - c. Hoffman; brand of nVent Electrical plc.
  - d. Hubbell Industrial Controls; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - e. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - f. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
  - g. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - h. Spring City Electrical Manufacturing Company.
  - i. Square D; Schneider Electric USA.
3. Options:
  - a. Degree of Protection: Type 1.

D. UL BGUZ - Indoor Cast-Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Adalet.
  - b. Appleton; Emerson Electric Co., Automation Solutions.
  - c. Crouse-Hinds; brand of Eaton, Electrical Sector.
  - d. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
3. Options:
  - a. Degree of Protection: Type 1.

E. UL BGUZ - Indoor Polymeric Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Allied Tube & Conduit; Atkore International.
  - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - c. Robroy Enclosures; Robroy Industries.
  - d. Topaz Lighting & Electric.
3. Options:
  - a. Degree of Protection: Type 1.

F. UL BGUZ - Outdoor Sheet Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Adalet.
  - b. Appleton; Emerson Electric Co., Automation Solutions.
  - c. Hoffman; brand of nVent Electrical plc.
  - d. Hubbell Industrial Controls; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - e. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - f. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
  - g. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - h. Spring City Electrical Manufacturing Company.
  - i. Square D; Schneider Electric USA.
3. Options:
  - a. Degree of Protection: Type 3R.

G. UL BGUZ - Outdoor Cast-Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Adalet.
  - b. Appleton; Emerson Electric Co., Automation Solutions.
  - c. Crouse-Hinds; brand of Eaton, Electrical Sector.
  - d. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
3. Options:
  - a. Degree of Protection: Type 3R.

H. UL BGUZ - Outdoor Polymeric Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Allied Tube & Conduit; Atkore International.
  - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - c. Robroy Enclosures; Robroy Industries.
3. Options:
  - a. Degree of Protection: Type 3R.

2.3 COVER PLATES FOR DEVICES BOXES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. Listing Criteria: UL CCN QCIT or UL CCN QCMZ; including UL 514D.
3. Wallplate-Securing Screws: Metal with head color to match wallplate finish.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL QCIT or QCMZ - Metallic Cover Plates for Device Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Appleton; Emerson Electric Co., Automation Solutions.
  - b. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - c. Crouse-Hinds; brand of Eaton, Electrical Sector.
  - d. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - e. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - f. Leviton Manufacturing Co., Inc.
  - g. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
  - h. Pass & Seymour; Legrand North America, LLC.
  - i. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - j. Wiremold; Legrand North America, LLC.
2. Options:
  - a. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.

- b. Wallplate Material: 0.032 inch thick, Type 302/304 non-magnetic stainless steel with brushed finish.

## 2.4 HOODS FOR OUTLET BOXES

### A. Performance Criteria:

- 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- 2. Listing Criteria:
  - a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.
  - b. Receptacle, Hood, Cover Plate, Gaskets, and Seals: UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.
- 3. Mounts to box using fasteners different from wiring device.

### B. Source Quality Control:

- 1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
- 2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

### C. UL QCIT or QCMZ - Retractable or Reattachable Hoods for Outlet Boxes:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Business.
  - b. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
- 2. Options:
  - a. Provides clear, weatherproof, "while-in-use" cover.

### D. UL QCIT or QCMZ - Extra-Duty, While-in-Use Hoods for Outlet Boxes:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Business.
  - b. Allied Tube & Conduit; Atkore International.
  - c. Appleton; Emerson Electric Co., Automation Solutions.
  - d. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - e. Leviton Manufacturing Co., Inc.
  - f. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
- 2. Additional Characteristics: Marked "Extra-Duty" in accordance with UL 514D.
- 3. Options:
  - a. Provides clear, weatherproof, "while-in-use" cover.
  - b. Manufacturer may combine nonmetallic device box with hood as extra-duty rated assembly.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Shop Drawings: Prepare and submit the following:
  - 1. Shop Drawings for Floor Boxes: Show that floor boxes are located to avoid interferences and are structurally allowable. Indicate floor thickness at location where boxes are embedded in concrete floors and underfloor clearances where boxes are installed in raised floors.

### 3.2 SELECTION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.
- B. Degree of Protection:
  - 1. Outdoors:
    - a. Type 3R unless otherwise indicated.
    - b. Locations Exposed to Hosedown: Type 4.
    - c. Locations Subject to Potential Flooding: Type 6P.
    - d. Locations Aboveground Where Mechanism Must Operate When Ice Covered: Type 3S.
    - e. Locations in-Ground or Exposed to Corrosive Agents: Type 4X.
    - f. Locations in-Ground or Exposed to Corrosive Agents Where Mechanism Must Operate When Ice Covered: Type 3SX.
  - 2. Indoors:
    - a. Type 1 unless otherwise indicated.
    - b. Damp or Dusty Locations: Type 4.
    - c. Surface Mounted in Kitchens and Other Locations Exposed to Oil or Coolants: Type 12.
    - d. Flush Mounted in Kitchens and Other Locations Exposed to Oil or Coolants: Type 12.
    - e. Locations Exposed to Airborne Dust, Lint, Fibers, or Flyings: Type 4.
    - f. Locations Exposed to Hosedown: Type 4.
    - g. Locations Exposed to Corrosive Agents: Type 4X.
    - h. Locations Exposed to Spraying Oil or Coolants: Type 13.
- C. Exposed Boxes Installed Less Than 2.5 m (8 ft) Above Floor:
  - 1. Provide cast-metal boxes.
  - 2. Provide exposed cover. Flat covers with angled mounting slots or knockouts are prohibited.

### 3.3 INSTALLATION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

- A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Outlet, Device, Pull, and Junction Boxes: Article 314 of NFPA 70.
2. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.
2. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
3. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box, whether installed indoors or outdoors.
4. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
5. Locate boxes so that cover or plate will not span different building finishes.
6. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.
7. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.
8. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
9. Set metal floor boxes level and flush with finished floor surface.
10. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
11. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.
12. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
13. Boxes and Enclosures in Areas or Walls with Acoustical Requirements:
  - a. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty.
  - b. Provide gaskets for wallplates and covers.
14. Identification: Provide labels for boxes and associated electrical equipment.
  - a. Identify field-installed conductors, interconnecting wiring, and components.
  - b. Provide warning signs.
  - c. Label each box with engraved metal or laminated-plastic nameplate.

### 3.4 CLEANING

A. Remove construction dust and debris from boxes before installing wallplates, covers, and hoods.

3.5 PROTECTION

- A. After installation, protect boxes from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION



## SECTION 260533.23

### SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. Surface metal raceways and fittings.
2. Surface nonmetallic raceways.
3. Strut-type channel raceways and fittings.
4. Wireways and auxiliary gutters.

###### B. Products Installed, but Not Furnished, under This Section:

1. See Section 260553 "Identification for Electrical Systems" for electrical equipment labels.

###### C. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.

##### 1.2 ACTION SUBMITTALS

###### A. Product Data:

1. Surface metal raceways and fittings.
2. Strut-type channel raceways and fittings.
3. Wireways and auxiliary gutters.

##### 1.3 INFORMATIONAL SUBMITTALS

###### A. Manufacturers' Published Instructions:

1. Surface metal raceways and fittings.
2. Strut-type channel raceways and fittings.
3. Wireways and auxiliary gutters.

#### PART 2 - PRODUCTS

##### 2.1 SURFACE METAL RACEWAYS AND FITTINGS

###### A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria: UL CCN RJBT; including UL 5.

###### B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.
3. Samples:
  - a. Surface Metallic Raceway Nonmetallic Cover Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type, 12 inch (300 mm).

C. UL RJBT - Surface Metal Raceways and Fittings with Metal Covers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - b. MonoSystems, Inc.
  - c. Wiremold; Legrand North America, LLC.
2. Options:
  - a. Galvanized steel base with snap-on covers.
  - b. Manufacturer's standard enamel finish in color as selected by Architect.
  - c. Wiring Channels: Dual. Multiple channels must be capable of housing a standard 20 to 30 A device flush within the raceway.

## 2.2 STRUT-TYPE CHANNEL RACEWAYS AND FITTINGS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria:
  - a. UL CCN RIUU; including UL 5B.
  - b. UL 94, V-0 requirements for self-extinguishing characteristics.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.
3. Samples:
  - a. Strut-Type Channel Raceway Nonmetallic Covers for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type, 12 inch (300 mm) long.

C. UL RIUU - Strut-Type Channel Raceways and Fittings with Metallic Covers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Cooper B-line; brand of Eaton, Electrical Sector.
  - b. Power-Strut; Atkore International.
  - c. Unistrut; Atkore International.
2. Options:
  - a. Manufacturer's standard enamel finish in color as selected by Architect.

## 2.3 WIREWAYS AND AUXILIARY GUTTERS

### A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria:
  - a. UL CCN ZOYX; including UL 870.
  - b. UL 94, V-0 requirements for self-extinguishing characteristics.

### B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.
3. Samples:
  - a. Nonmetallic Wireway and Auxiliary Gutter Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type, 12 inch (300 mm) long.

### C. UL ZOYX - Metal Wireways and Auxiliary Gutters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Cooper B-line; brand of Eaton, Electrical Sector.
  - b. Hoffman; brand of nVent Electrical plc.
  - c. Square D; Schneider Electric USA.
2. Additional Characteristics:
  - a. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
  - b. Finish: Manufacturer's standard enamel finish.
3. Options:
  - a. Degree of Protection: Type 1 or Type 3R as required on the drawings.

b. Wireway Covers: Flanged-and-gasketed type unless otherwise indicated.

D. UL ZOYX - Nonmetallic Wireways and Auxiliary Gutters:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Hoffman; brand of nVent Electrical plc.
2. Additional Characteristics:
  - a. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings must match and mate with wireways as required for complete system.
  - b. PVC Solvents and Adhesives: As recommended by wireway manufacturer.
3. Options:
  - a. Material:
    - 1) Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover must be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections must be flanged and have stainless steel screws and oil-resistant gaskets.
    - 2) PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURFACE RACEWAYS FOR ELECTRICAL SYSTEMS

- A. Comply with manufacturer's published instructions.
- B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:
  1. Auxiliary Gutters: Article 366 of NFPA 70.
  2. Surface Metal Raceway: Article 386 of NFPA 70.
  3. Surface Nonmetallic Raceway: Article 388 of NFPA 70.
  4. Consult Architect for resolution of conflicting requirements.
- C. Special Installation Techniques:
  1. Install surface raceways only where indicated on Drawings.
  2. Install surface raceway with a minimum 2 inch (50 mm) radius control at bend points.
  3. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inch (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway in accordance with manufacturer's published instructions. Tape and glue are unacceptable support methods.
  4. Identification: Provide labels for surface raceways and associated electrical equipment.
    - a. Identify field-installed conductors, interconnecting wiring, and components.
    - b. Provide warning signs.

3.2 CLEANING

- A. Remove construction dust and debris from surface raceways before installing covers.

3.3 PROTECTION

- A. After installation, protect surface raceways from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION

## SECTION 260543

### UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. Type ERM-C-S raceways, elbows, couplings, and nipples.
2. Type IMC raceways.
3. Type PVC raceways and fittings.
4. Fittings for conduit, tubing, and cable.
5. Electrically conductive corrosion-resistant compounds for threaded conduit.
6. Solvent cements.
7. Duct accessories.
8. Handholes and boxes for exterior underground wiring.
9. Duct sealing.

###### B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section
2. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" for nonmetallic underground conduit with conductors (Type NUCC).

##### 1.2 DEFINITIONS

- A. Duct: A single raceway or multiple raceways, installed singly or as components of a duct bank.
- B. Duct Bank: Two or more ducts installed in parallel, direct buried or with additional casing materials such as concrete.
- C. Handhole: An underground chamber containing electrical cables, sized such that personnel are not required to enter in order to access the cables.
- D. Manhole: An underground chamber containing electrical cables and equipment, sized to provide access with working space clearances.
- E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

##### 1.3 ACTION SUBMITTALS

###### A. Product Data:

1. Type ERM-C-S raceways, elbows, couplings, and nipples.
2. Type IMC raceways.
3. Type PVC raceways and fittings.
4. Fittings for conduit, tubing, and cable.
5. Electrically conductive corrosion-resistant compounds for threaded conduit.
6. Solvent cements.
7. Duct accessories.

8. Handholes and boxes for exterior underground wiring.
9. Utility structure accessories.
10. Duct sealing.

B. Shop Drawings:

1. Electric Utility Duct Banks and Structures:

- a. Include plans, elevations, sections, and details, including attachments to other Work.
- b. Indicate locations of private property boundaries and utility easements.
- c. Include information required for approval by electric utility and for obtaining public space utility work permits.

2. Precast or Factory-Fabricated Concrete Structures:

- a. Include plans, elevations, sections, and details, including attachments to other Work.
- b. Include duct entry provisions, including locations and duct sizes, and methods and materials for waterproofing duct entry locations.
- c. Include reinforcement details.
- d. Include frame and cover design and manhole chimneys.
- e. Include ladder details.
- f. Include grounding details.
- g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, sumps, and other accessories.
- h. Include joint details.

3. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

- a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
- b. Include duct entry provisions, including locations and duct sizes, and methods and materials for waterproofing duct entry locations.
- c. Include cover design.
- d. Include grounding details.
- e. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and other accessories.

C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

- A. Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C858.
- B. Manufacturers' published instructions.
- C. Field Reports:
  1. Factory Test Reports: For handholes and boxes.
  2. Manufacturer's field reports for field quality-control support.

1.5 REGULATORY AGENCY APPROVALS

- A. Shop Drawing submittals for electric utility duct banks and structures must be signed and sealed by qualified electrical professional engineer responsible for their preparation. Obtain approval by electric utility prior to submitting for action by Architect.
- B. Submit Shop Drawings for electric utility duct banks and structures for action by Architect prior to submitting for approval by electric utility.

## PART 2 - PRODUCTS

### 2.1 TYPE ERMC-S RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

- A. Performance Criteria:
  - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
  - 2. General Characteristics: UL 6 and UL CCN DYIX.
- B. Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit; Atkore International.
    - b. Crouse-Hinds; brand of Eaton, Electrical Sector.
    - c. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - d. Republic Conduit; Nucor Corporation, Nucor Tubular Products.
    - e. Western Tube; Zekelman Industries.
    - f. Wheatland Tube; Zekelman Industries.
  - 2. Exterior Coating: Zinc.
  - 3. Options:
    - a. Interior Coating: Zinc with organic top coating.
    - b. Minimum Trade Size: Metric designator 21 (trade size 3/4).

### 2.2 TYPE IMC RACEWAYS

- A. Performance Criteria:
  - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
  - 2. General Characteristics: UL 1242 and UL CCN DYBY.
- B. Steel Electrical Intermediate Metal Conduit (IMC):
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit; Atkore International.
    - b. Republic Conduit; Nucor Corporation, Nucor Tubular Products.
    - c. Western Tube; Zekelman Industries.
    - d. Wheatland Tube; Zekelman Industries.
  - 2. Options:



- a. Exterior Coating: Zinc.
- b. Interior Coating: Zinc with organic top coating.
- c. Minimum Trade Size: Metric designator 21 (trade size 3/4).

## 2.3 TYPE PVC RACEWAYS AND FITTINGS

### A. Performance Criteria:

- 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- 2. General Characteristics: UL 651 and UL CCN DZYR.

### B. Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Business.
  - b. JM Eagle.
- 2. Dimensional Specifications: Schedule 40.
- 3. Options:
  - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
  - b. Markings: For use with maximum 90 deg C wire.

### C. Schedule 80 Rigid PVC Conduit (PVC-80) and Fittings:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Business.
  - b. JM Eagle.
- 2. Dimensional Specifications: Schedule 80.
- 3. Options:
  - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
  - b. Markings: For use with maximum 90 deg C wire.

### D. Type A Rigid PVC Concrete-Encased Conduit (PVC-A) and Fittings:

- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Southern Pipe, Inc.
- 2. Dimensional Specifications: Type A.
- 3. Options:
  - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

### E. Type EB Rigid PVC Concrete-Encased Underground Conduit (PVC-EB) and Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. JM Eagle.
  - b. Southern Pipe, Inc.
2. Dimensional Specifications: Type EB.
3. Options:
  - a. Minimum Trade Size: Metric designator 53 (trade size 2).

#### 2.4 FITTINGS FOR CONDUIT, TUBING, AND CABLE

##### A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

##### B. Metallic Fittings for Type ERM, Type IMC, and Type PVC Raceways:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Business.
  - b. Appleton; Emerson Electric Co., Automation Solutions.
  - c. Crouse-Hinds; brand of Eaton, Electrical Sector.
  - d. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
  - e. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - f. Southwire Company, LLC.
2. General Characteristics: UL 514B and UL CCN DWTT.
3. Options:
  - a. Material: Steel.
  - b. Coupling Method: Setscrew coupling. Setscrew couplings with only single screw per conduit are unacceptable.
  - c. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
  - d. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

#### 2.5 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT

##### A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: UL Subject 2419 and UL CCN FOIZ.

##### B. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. ABB, Electrification Business.

## 2.6 SOLVENT CEMENTS

### A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics: As recommended by conduit manufacturer in accordance with UL 514B and UL CCN DWTT.
3. Sustainability Characteristics:

### B. Solvent Cements for Type PVC Raceways and Fittings:

## 2.7 DUCT ACCESSORIES

### A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Business.
  - b. Allied Tube & Conduit; Atkore International.

### B. Underground-Line Warning Tape: In accordance with Section 260553 "Identification for Electrical Systems."

### C. Concrete Warning Planks: Nominal 12 by 24 by 3 inch (300 by 600 by 75 mm) in size, manufactured from 6000 psi (41 MPa) concrete.

1. Color: Red dye added to concrete during batching.
2. Mark each plank with "ELECTRIC" in 2 inch (50 mm) high, 3/8 inch (10 mm) deep letters.

## 2.8 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

### A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:
  - a. ASTM C858 for design and manufacturing processes.
  - b. SCTE 77.

### B. Fiberglass Handholes and Boxes:

1. Description: Molded of fiberglass-reinforced polyester resin, with covers made of reinforced fiberglass.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. MacLean Highline.
  - b. Nordic Fiberglass, Inc.
  - c. Oldcastle Infrastructure Inc.; CRH Americas.

- d. Quazite; brand of Hubbell Utility Solutions; Hubbell Incorporated.
- 3. Configuration: Units must be designed for flush burial and have open bottom unless otherwise indicated.
- 4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
  - a. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
  - b. Cover Legend: Molded lettering, "ELECTRIC" as indicated for each service.
- 5. Duct Entrance Provisions: Duct-terminating fittings must mate with entering duct for secure, fixed installation in enclosure wall.
- 6. Handholes 12 inch wide by 24 inch long (300 mm wide by 600 mm long) and larger must have factory-installed inserts for cable racks and pulling-in irons.
- 7. Options:
  - a. Color: Green.

## 2.9 DUCT SEALING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ABB, Electrification Business.
  - 2. American Polywater Corporation.
  - 3. CommScope, Inc.
  - 4. Gardner Bender.
- B. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Compound must be capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduit, conduit and duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals. Duct sealing compound must be removable without damaging ducts or cables.
- C. Inflatable Duct-Sealing System: Wraparound inflatable bladder that seals ducts that are empty or containing conductors against air and water infiltration. System is suitable for use in steel, plastic, or concrete ducts and penetrations.

## 2.10 SOURCE QUALITY CONTROL

- A. Product Data: Prepare and submit catalog cuts, brochures, diagrams, schedules, and performance data illustrating size, physical appearance, and other characteristics of product.
  - 1. Duct-bank materials, including spacers and miscellaneous components.
  - 2. Ducts, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
  - 3. Accessories for handholes, boxes.
  - 4. Underground-line warning tape.
  - 5. Warning planks.
- B. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.
- C. Factory Tests for Handholes and Boxes:

1. Testing Administrant: Engage qualified structural testing agency to evaluate handholes and boxes.
  - a. Strength tests of complete boxes and covers must be by independent testing agency or manufacturer. Qualified registered professional engineer must certify tests by manufacturer.
2. Factory Tests and Inspections: Perform the following tests and inspections on handholes and boxes, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, before delivering to site. Affix label with name and date of qualified testing laboratory's certification of system compliance.
  - a. Precast Concrete Utility Structures: Test and inspect in accordance with ASTM C1037.
  - b. Polymer Concrete and Nonconcrete Handhole and Pull-Box Prototypes: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests must be for specified tier ratings of products supplied. Testing machine pressure gages must have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.
3. Nonconforming Work:
  - a. Equipment that does not pass tests and inspections will be considered defective.
4. Factory Test Reports: Prepare and submit factory test and inspection reports.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in field. Notify Architect if there is conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.
- C. Clear and grub vegetation to be removed and protect vegetation to remain in accordance with Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication in accordance with Section 311000 "Site Clearing."

#### 3.2 SELECTION OF UNDERGROUND DUCTS

- A. Duct for Electrical Feeders 600 V and Less: PVC-40 concrete encased unless otherwise indicated.
- B. Duct for Electrical Branch Circuits: PVC-40, direct buried unless otherwise indicated.
- C. Underground Ducts Crossing Paved Paths, Walks, and Driveways: PVC-80.
- D. Underground Ducts Crossing Roadways: PVC-80, encased in reinforced concrete.

- E. Stub-ups: Concrete encased, PVC-40.

### 3.3 SELECTION OF UNDERGROUND ENCLOSURES

#### A. Handholes and Boxes:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete, AASHTO HB 17, [H-10] [H-20] structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Fiberglass-reinforced polyester resin, SCTE 77, Tier 15 structural load rating.
3. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested in accordance with SCTE 77 with 3000 lbf (13 345 N) vertical loading.
4. Cover design load must not exceed load rating of handhole or box.

### 3.4 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."
- D. Cut and patch existing pavement in path of underground duct, duct bank, and underground structures in accordance with "Cutting and Patching" Article in Section 017300 "Execution."

### 3.5 INSTALLATION OF DUCTS AND DUCT BANKS

#### A. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA TCB 2 for installation of underground ducts and duct banks.
2. Consult Architect for resolution of conflicting requirements.

#### B. Special Techniques:

1. Where indicated on Drawings, install duct, spacers, and accessories into duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
2. Slope: Pitch duct minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from high point between two manholes to drain in both directions.
3. Expansion and Deflection Fittings: Install expansion and deflection fitting in each duct in area of disturbed earth adjacent to handhole.
4. Install expansion fitting near center of straight line duct with calculated expansion of more than 3/4 inch (19 mm).
5. Curves and Bends:

- a. Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with minimum radius of 48 inch (1200 mm), both horizontally and vertically, at other locations unless otherwise indicated.
  - b. Field bending must be in accordance with NFPA 70 minimum radii requirements, except bends over 45 degrees must be made with minimum radius of 48 inch (1200 mm). Use only equipment specifically designed for material and size involved. Use PVC heating bender for bending PVC conduit.
  - c. Duct must have maximum of 180 degrees of bends between pull points.
6. Joints: Use solvent-cemented joints in nonmetallic duct and fittings and make watertight in accordance with manufacturer's published instructions. Stagger couplings so those of adjacent duct do not lie in same plane. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with minimum 3 inch (75 mm) of concrete for minimum of 12 inch (300 mm) on each side of coupling.
- a. Install insulated grounding bushings on steel raceway terminations that are less than 12 inch (300 mm) below grade or floor level and do not terminate in hubs.
7. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing duct will not be subject to environmental temperatures above 104 deg F (40 deg C). Where environmental temperatures are calculated to rise above 104 deg F (40 deg C), and anywhere duct crosses above underground steam line, install insulation blankets listed for direct burial to isolate duct bank from steam line to maintain maximum environmental temperature of 104 deg F (40 deg C).
8. Building Wall Penetrations: Make transition from underground duct to steel raceway at least 10 ft (3 m) outside building wall, without reducing duct line slope away from building and without forming trap in line. Use fittings manufactured for transition to steel raceway type installed. Install steel raceway penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
9. Install manufactured steel raceway elbows for stub-ups at poles unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
- a. Couple steel elbows to ducts with adapters designed for this purpose, and encase coupling with minimum 3 inch (75 mm) of concrete for minimum of 12 inch (300 mm) on each side of coupling.
10. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15 psig (1.03 MPa) hydrostatic pressure.
11. Pulling Cord: Install 200 lbf (1000 N) test nylon cord in empty ducts.
12. Concrete-Encased Ducts and Duct Bank:
- a. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes 6 inch (150 mm) or less in nominal diameter.
  - b. Width: Excavate trench 12 inch (300 mm)] wider than duct on each side.
  - c. Depth: Install so top of duct envelope is at least 24 inch (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inch (750 mm) below finished grade in deliberate traffic paths for vehicles unless otherwise indicated. Install so top of duct envelope is below local frost line.
  - d. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.

- e. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per 20 ft (6 m) of duct. Place spacers within 24 inch (600 mm) of duct ends. Stagger spacers approximately 6 inch (150 mm) between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
- f. Minimum Space between Ducts: 3 inch (75 mm) between edge of duct and exterior envelope wall, 2 inch (50 mm) between ducts for like services, and 4 inch (100 mm) between power and communications ducts.
- g. Elbows:
  - 1) Use manufactured duct elbows for stub-ups and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.
- h. Stub-ups to Outdoor Equipment: Extend concrete-encased steel raceway horizontally minimum of 60 inch (1500 mm) from edge of equipment base.
  - 1) Stub-ups must be minimum 4 inch (100 mm) above finished floor and minimum 3 inch (75 mm) from conduit side to edge of slab.
- i. Stub-ups to Indoor Equipment: Extend concrete-encased steel raceway horizontally minimum of 60 inch (1500 mm) from edge of wall. Install insulated grounding bushings on terminations at equipment.
  - 1) Stub-ups must be minimum 4 inch (100 mm) above finished floor and no less than 3 inch (75 mm) from conduit side to edge of slab.
- j. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
- k. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
- l. Concrete Cover: Install minimum of 3 inch (75 mm) of concrete cover between edge of duct to exterior envelope wall, 2 inch (50 mm) between duct of like services, and 4 inch (100 mm) between power and communications ducts.
- m. Place minimum 6 inch (150 mm) of engineered fill above concrete encasement of duct.
- n. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
  - 1) Start at one end and finish at other, allowing for expansion and contraction of duct as its temperature changes during and after pour. Use expansion fittings installed in accordance with manufacturer's published instructions or use other specific measures to prevent expansion-contraction damage.
  - 2) If more than one pour is necessary, terminate each pour in vertical plane and install 3/4 inch (15 mm) reinforcing-rod dowels extending minimum of 18 inch (450 mm) into concrete on both sides of joint near corners of envelope.
- o. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow heavy mass of concrete to fall directly onto ducts. Allow concrete to flow



around duct and rise up in middle, uniformly filling open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.

13. Direct-Buried Duct and Duct Bank:

- a. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inch (150 mm) in nominal diameter.
- b. Width: Excavate trench 12 inch (300 mm) wider than duct on each side.
- c. Depth: Install top of duct at least 36 inch (900 mm) below finished grade unless otherwise indicated.
- d. Set elevation of top of duct bank below frost line.
- e. Place minimum 3 inch (75 mm) of sand as bed for duct. Place sand to minimum of 6 inch (150 mm) above top level of duct.
- f. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
- g. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per 20 ft (6 m) of duct. Place spacers within 24 inch (600 mm) of duct ends. Stagger spacers approximately 6 inch (150 mm) between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
- h. Install duct with minimum of 3 inch (75 mm) between ducts for like services and 6 inch (150 mm) between power and communications duct.
- i. Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
  - 1) Couple RNC duct to steel raceway with adapters designed for this purpose, and encase coupling with minimum 3 inch (75 mm) of concrete.
  - 2) Stub-ups to Outdoor Equipment: Extend concrete-encased steel raceway horizontally minimum of 60 inch (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.
    - a) Stub-ups must be minimum 4 inch (100 mm) above finished base and minimum 3 inch (75 mm) from conduit side to edge of base.
  - 3) Stub-ups to Indoor Equipment: Extend concrete-encased steel raceway horizontally on exterior of wall minimum of 60 inch (1500 mm) from edge of wall. Install insulated grounding bushings on terminations at equipment.
  - 4) Stub-ups through interior floors must be minimum 4 inch (100 mm) above finished floor and no less than 3 inch (75 mm) from conduit side to edge of equipment pad or floor slab.
- j. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inch (100 mm) over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.

14. Warning Planks: Bury warning planks approximately 12 inch (300 mm) above direct-buried duct, placing them 36 inch (900 mm) o.c. Align planks along width and along centerline of duct or duct bank. Provide additional plank for each 12 inch (300 mm) increment of duct-bank width over nominal 18 inch (450 mm). Space additional planks 12 inch (300 mm) apart, horizontally across width of ducts.
15. Underground-Line Warning Tape: Bury conducting underground line specified in Section 260553 "Identification for Electrical Systems" no less than 12 inch (300 mm) above concrete-encased duct and duct banks and approximately 12 inch (300 mm) below grade. Align tape parallel to and within 3 inch (75 mm) of centerline of duct bank. Provide additional warning tape for each 12 inch (300 mm) increment of duct-bank width over nominal 18 inch (450 mm). Space additional tapes 12 inch (300 mm) apart, horizontally across width of ducts.
16. Ground ducts and duct banks in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

### 3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

#### A. Reference Standards:

1. Consult Engineer for resolution of conflicting requirements.

#### B. Special Techniques:

1. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.
2. Unless otherwise indicated, support units on level bed of crushed stone or gravel, graded from 1/2 inch (12.5 mm) sieve to No. 4 (4.75 mm) sieve and compacted to same density as adjacent undisturbed earth.
3. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
4. Install handholes and boxes with bottom below frost line, below grade.
5. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
6. Field cut openings for duct in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
7. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour concrete ring encircling, and in contact with enclosure entry, and with top surface screeded to top of box cover frame. Bottom of ring must rest on compacted earth.
  - a. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with troweled finish.
  - b. Dimensions: 10 inch wide by 12 inch deep (250 mm wide by 300 mm deep).
8. Ground handholes and boxes in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

### 3.7 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
- B. Field tests and inspections must be witnessed by authorities having jurisdiction.
- C. Tests and Inspections:
  - 1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
  - 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide minimum 12 inch (300 mm) long mandrel equal to duct size minus 1/4 inch (6 mm). If obstructions are indicated, remove obstructions and retest.
  - 3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Nonconforming Work:
  - 1. Underground ducts, raceways, and structures will be considered defective if they do not pass tests and inspections.
  - 2. Correct deficiencies and retest as specified above to demonstrate compliance.
- E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.
- F. Manufacturer Services: Engage factory-authorized service representative to support field tests and inspections.
  - 1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at Project site.

### 3.8 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

END OF SECTION 260543

## SECTION 260544

### SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

#### PART 1 - GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. Round sleeves.
2. Rectangular sleeves.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.
6. Pourable sealants.
7. Foam sealants.

###### B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.
2. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

##### 1.2 ACTION SUBMITTALS

###### A. Product Data: For each type of product.

#### PART 2 - PRODUCTS

##### 2.1 ROUND SLEEVES

###### A. Steel Wall Sleeves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Advance Products & Systems, LLC.
  - b. CCI Piping Systems.
  - c. Flexicraft Industries.
2. General Characteristics: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

###### B. Cast-Iron Wall Sleeves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. American Cast Iron Pipe Company.
  - b. Flexicraft Industries.

- c. McWane Ductile.
  - 2. General Characteristics: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.
  - 3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CCI Piping Systems.
    - b. GPT; an EnPro Industries company.
    - c. Metraflex Company (The).
  - 4. General Characteristics: ASTM D1785, Schedule 40.
- C. PVC Molded Sleeves:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ABB, Electrification Business.
    - b. American Polywater Corporation.
    - c. Arlington Industries, Inc.
    - d. Reliance Worldwide Corporation.
  - 2. General Characteristics: With nailing flange for attaching to wooden forms.
- D. PE or PP Molded Sleeves:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Polywater Corporation.
    - b. Crete-Sleeve.
  - 2. General Characteristics: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- E. Round, Galvanized-Steel, Sheet Metal Sleeves:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Benefast.
    - b. Specified Technologies, Inc.
  - 2. General Characteristics: Galvanized-steel sheet; thickness not less than 0.0239 inch (0.6 mm); round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

## 2.2 RECTANGULAR SLEEVES

### A. Rectangular, Galvanized-Steel, Sheet Metal Sleeves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Abesco Fire LLC.
- b. Specified Technologies, Inc.
- c. Wiremold; Legrand North America, LLC.

2. General Characteristics:

- a. Material: Galvanized sheet steel.
- b. Minimum Metal Thickness:
  - 1) For sleeve cross-section rectangle perimeter less than 50 inch (1270 mm) and with no side larger than 16 inch (400 mm), thickness must be 0.052 inch (1.3 mm).
  - 2) For sleeve cross-section rectangle perimeter not less than 50 inch (1270 mm) or with one or more sides larger than 16 inch (400 mm), thickness must be 0.138 inch (3.5 mm).

2.3 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Advance Products & Systems, LLC.
  2. BWM Company.
  3. CALPICO, Inc.
  4. Flexicraft Industries.
- B. General Characteristics: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.
- C. Options:
  1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  2. Pressure Plates: Carbon steel.
  3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  1. Holdrite; a division of Reliance Worldwide Corporation.
- B. General Characteristics: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit must have plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  1. W. R. Meadows, Inc.
- B. General Characteristics: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Design Mix: 5000 psi (34.5 MPa), 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

## 2.6 POURABLE SEALANTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carlisle Syntec Systems.
  2. GAF.
  3. Johns Manville; a Berkshire Hathaway company.
- B. Performance Criteria:
1. General Characteristics: Single-component, neutral-curing elastomeric sealants of grade indicated below.
    - a. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

## 2.7 FOAM SEALANTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Innovative Chemical Products (Building Solutions Group).
  2. The Dow Chemical Company.
- B. Performance Criteria:
1. General Characteristics: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam. Foam expansion must not damage cables or crack penetrated structure.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:
1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
    - a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
    - b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
  2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

3. Size pipe sleeves to provide 1/4 inch (6.4 mm) annular clear space between sleeve and raceway or cable, unless sleeve-seal system is to be installed or seismic criteria require different clearance.
  4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
  5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inch (50 mm) above finished floor level. Install sleeves during erection of floors.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
  2. Seal space outside of sleeves with approved joint compound for wall assemblies.
- C. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- D. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve-seal systems. Size sleeves to allow for 1 inch (25 mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- E. Underground, Exterior-Wall and Floor Penetrations:
1. Install steel pipe sleeves with integral waterstops. Size sleeves to allow for 1 inch (25 mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Install sleeve during construction of floor or wall.
- 3.2 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS
- A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.
  - B. Install conduits and cable with no crossings within the sleeve.
  - C. Fill opening around conduits and cables with expanding foam without leaving voids.
  - D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.
- 3.3 INSTALLATION OF SLEEVE-SEAL SYSTEMS
- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
  - B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

END OF SECTION



## SECTION 260548

### VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. Elastomeric isolation pads.
2. Restraints - rigid type.
3. Restraints - cable type.
4. Restraint accessories.
5. Post-installed concrete anchors.
6. Concrete inserts.

###### B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.
2. Section 260529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

##### 1.2 DEFINITIONS

- ###### A. OSHPD: Office of Statewide Health Planning and Development (for the State of California owned and regulated medical facilities).

##### 1.3 ACTION SUBMITTALS

###### A. Product Data:

1. Elastomeric isolation pads.
2. Restraints - rigid type.
3. Restraints - cable type.
4. Restraint accessories.
5. Post-installed concrete anchors.
6. Concrete inserts.

###### B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
3. Show coordination of seismic and wind-load bracing for components with other systems and equipment in the vicinity, including other supports and seismic restraints.

- ###### C. Delegated Design Submittal for Each Seismic-Restraint Device: Signed and sealed by qualified structural professional engineer.

1. For each seismic-restraint device, including restraint - rigid and cable type, restraint accessory, and concrete anchor and insert that is required by this Section or is indicated on Drawings, submit the following:
  - a. Seismic Restraints: Select seismic restraints complying with performance requirements, design criteria, and analysis data.
  - b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated seismic loads. Include certification that device is approved by qualified testing laboratory for seismic reinforcement use.
  - c. Seismic Design Calculations: Submit input data and loading calculations prepared in accordance with criteria specified in Section 260000 "General Requirements for Electrical," apply to this Section.
  
- D. Delegated Design Submittal for Each Wind-Load Protection Device: Signed and sealed by qualified structural professional engineer.
  1. For each wind-load protection device, including restraint - rigid and cable type, restraint accessory, and concrete anchor and insert that is required by this Section or is indicated on Drawings, submit the following:
    - a. Wind-Load Restraint: Select wind-load restraints complying with performance requirements, design criteria, and analysis data.
    - b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated wind loads. Include certification that device is approved by qualified testing laboratory for reinforcement use.
    - c. Wind-Load Design Calculations: Submit static and dynamic loading calculations prepared in accordance with criteria specified in Section 260010 "Supplemental Requirements for Electrical" and Section 260011 "Facility Performance Requirements for Electrical."
  
  2. Seismic- and Wind-Load-Restraint Detail Drawings: Signed and sealed by qualified structural professional engineer.
    - a. Design Analysis: To support selection and arrangement of seismic and wind-load restraints. Include calculations of combined tensile and shear loads.
    - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
    - c. Coordinate seismic-restraint details with wind-load details required for equipment mounted outdoors.
  
  3. Product Listing, Preapproval, and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
  
- E. Field quality-control reports.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage qualified structural professional engineer to design seismic and wind-load control system in accordance with criteria specified in Section 260010 "Supplemental

Requirements for Electrical" and Section 260011 "Facility Performance Requirements for Electrical."

- B. Seismic- and Wind-Load-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by an agency acceptable to authorities having jurisdiction.
- C. Consequential Damage: Provide additional seismic and wind-load restraints for suspended components or anchorage of floor-, roof-, or wall-mounted components so that failure of a non-essential or essential component will not cause failure of any other essential building component.
- D. Fire/Smoke Resistance: Seismic- and wind-load-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by qualified testing laboratory in accordance with ASTM E84 or UL 723 and be so labeled.
- E. Component Supports:
  - 1. Load ratings, features, and applications of reinforcement components must be based on testing standards of qualified testing laboratory.

## 2.2 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Ace Mountings Co., Inc.
    - b. CADDY; brand of nVent Electrical plc.
    - c. Isolation Technology, Inc.
    - d. Kinetics Noise Control, Inc.
    - e. Vibration Eliminator Co., Inc.
    - f. Vibration Isolation.
    - g. Vibration Management Corp.
  - 2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
  - 3. Size: Factory or field cut to match requirements of supported equipment.
  - 4. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
  - 5. Surface Pattern: Smooth, ribbed, or waffle pattern.
  - 6. Infused nonwoven cotton or synthetic fibers.
  - 7. Load-bearing metal plates adhered to pads.
  - 8. Sandwich-Core Material: Resilient and elastomeric.
    - a. Surface Pattern: Smooth, ribbed, or waffle pattern.
    - b. Infused nonwoven cotton or synthetic fibers.

## 2.3 RESTRAINTS - RIGID TYPE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. CADDY; brand of nVent Electrical plc.
  - 2. Cooper B-line; brand of Eaton, Electrical Sector.
  - 3. Unistrut; Atkore International.
  
- B. Description: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

## 2.4 RESTRAINTS - CABLE TYPE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. CADDY; brand of nVent Electrical plc.
  - 2. Cooper B-line; brand of Eaton, Electrical Sector.
  
- B. Seismic- and Wind-Load-Restraint Cables: ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket, or mechanical (Flemish eye) loop.
  
- C. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. Cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

## 2.5 RESTRAINT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. CADDY; brand of nVent Electrical plc.
  - 2. Cooper B-line; brand of Eaton, Electrical Sector.
  - 3. Unistrut; Atkore International.
  
- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Non-metallic stiffeners are unacceptable.
  
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
  
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.
  
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

## 2.6 POST-INSTALLED CONCRETE ANCHORS

### A. Mechanical Anchor Bolts:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Cooper B-line; brand of Eaton, Electrical Sector.
  - b. Unistrut; Atkore International.
- 2. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

### B. Adhesive Anchor Bolts:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Cooper B-line; brand of Eaton, Electrical Sector.
  - b. Unistrut; Atkore International.
- 2. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

### C. Provide post-installed concrete anchors that have been prequalified for use in seismic and wind-load applications.

- 1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
- 2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

### D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp (7.46 kW) that is not vibration isolated.

- 1. Undercut expansion anchors are permitted.

## 2.7 CONCRETE INSERTS

### A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Cooper B-line; brand of Eaton, Electrical Sector.
- 2. Unistrut; Atkore International.

### B. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC446 testing.

- C. Comply with MSS SP-58.

## 2.8 SOURCE QUALITY CONTROL

- A. Product Data: Prepare and submit catalog cuts, brochures, diagrams, and schedules, and performance data illustrating size, physical appearance, and other characteristics of product.
  - 1. Include rated load capacity for each seismic- and wind-load-restraint device.
  - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic- and wind-load-restraint component used.
  - 3. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by an agency acceptable to authorities having jurisdiction.
  - 4. Annotate to indicate application of each product submitted and compliance with requirements.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and equipment to receive seismic and wind-load control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry static, wind load, and seismic loads within specified loading limits.

### 3.3 INSTALLATION OF SEISMIC-RESTRAINT AND WIND-LOAD CONTROL DEVICES

- A. Provide seismic restraint and wind-load control devices for systems and equipment where indicated in Equipment Schedules or Seismic and Wind-Load Controls Schedule, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.
  - 1. Install equipment and devices to withstand the effects of earthquake motions and high wind events.
- B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

- C. Installation of seismic and wind-load restraints must not cause any stresses, misalignment, or change of position of equipment or conduits.
- D. Equipment Restraints:
  - 1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
  - 2. Install seismic-restraint and wind-load-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- E. Raceway, Cable, Wireway, Cable Tray, and Busway Support and Hanger Restraints:
  - 1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
  - 2. Install seismic-restraint and wind-load-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
  - 3. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
  - 4. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- F. Install cables so they do not bend across edges of adjacent equipment or building structure.
- G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- I. Post-Installed Concrete Anchors:
  - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
  - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
  - 3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors must be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
  - 4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
  - 5. Set anchors to manufacturer's recommended torque using a torque wrench.
  - 6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

### 3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different

structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

### 3.5 FIELD QUALITY CONTROL

- A. Field tests must be witnessed by authorities having jurisdiction.
- B. Tests and Inspections:
  - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
  - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
  - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  - 4. Test no fewer than four of each type and size of installed anchors and fasteners selected by Architect.
  - 5. Test to 90 percent of rated proof load of device.
- C. Nonconforming Work:
  - 1. Seismic controls will be considered defective if they do not pass tests and inspections.
  - 2. Remove and replace malfunctioning units and retest as specified above.
- D. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

END OF SECTION



## SECTION 260553

### IDENTIFICATION FOR ELECTRICAL SYSTEMS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

###### A. Section Includes:

1. Labels.
2. Bands and tubes.
3. Tapes and stencils.
4. Tags.
5. Signs.
6. Cable ties.
7. Miscellaneous identification products.

###### B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.

##### 1.3 ACTION SUBMITTALS

###### A. Product Data:

1. Labels.
2. Bands and tubes.
3. Tapes and stencils.
4. Tags.
5. Signs.
6. Cable ties.
7. Miscellaneous identification products.

- B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

- C. Identification Schedule: For each piece of electrical equipment and electrical system components to be index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

#### PART 2 - PRODUCTS

##### 2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1 and IEEE C2.

- B. Comply with 29 CFR 1910.144 for color identification of hazards; 29 CFR 1910.145 for danger, caution, warning, and safety instruction signs and tags; and the following:
  - 1. Fire-protection and fire-alarm equipment, including raceways, must be finished, painted, or suitably marked safety red.
  - 2. Ceiling-mounted hangers, supports, cable trays, and raceways must be finished, painted, or suitably marked safety yellow where less than 7.7 ft above finished floor.
- C. Signs, labels, and tags required for personnel safety must comply with the following standards:
  - 1. Safety Colors: NEMA Z535.1.
  - 2. Facility Safety Signs: NEMA Z535.2.
  - 3. Safety Symbols: NEMA Z535.3.
  - 4. Product Safety Signs and Labels: NEMA Z535.4.
  - 5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.
- D. Comply with NFPA 70E and Section 260573.19 "Arc-Flash Hazard Analysis" requirements for arc-flash warning labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, must comply with UL 969.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

## 2.2 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 1000 V or Less:
  - 1. Black letters on orange field.
  - 2. Legend: Indicate voltage and system or service type.
- B. Color-Coding for Phase- and Voltage-Level Identification, 1000 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
  - 1. Color must be factory applied or field applied for sizes larger than 8 AWG if authorities having jurisdiction permit.
  - 2. Colors for 208Y/120 V Circuits:
    - a. Phase A: Black.
    - b. Phase B: Red.
    - c. Phase C: Blue.
  - 3. Colors for 480Y/277 V Circuits:
    - a. Phase A: Brown.
    - b. Phase B: Orange.
    - c. Phase C: Yellow.
  - 4. Color for Neutral: White or gray.
  - 5. Color for Equipment Grounds: Bare copper and Green.
- C. Warning Label Colors:

1. Identify system voltage with black letters on orange background.

D. Warning labels and signs must include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 3 FEET MINIMUM."

E. Equipment Identification Labels:

1. Black letters on white field.

## 2.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brady Corporation.
  - b. Champion America.
  - c. Grafoplast Wire Markers.
  - d. HellermannTyton.
  - e. emedco.

B. Self-Adhesive Wraparound Labels: Preprinted, 3 mil thick, vinyl flexible label with acrylic pressure-sensitive adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brady Corporation.
  - b. Marking Services Inc.
  - c. Panduit Corp.
2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over legend. Labels sized such that clear shield overlaps entire printed legend.
3. Marker for Labels:
  - a. Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

C. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3 mil thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brady Corporation.
  - b. HellermannTyton.
  - c. Marking Services Inc.
  - d. Panduit Corp.

2. Minimum Nominal Size:
  - a. 1-1/2 by 6 inch for raceway and conductors.
  - b. 3-1/2 by 5 inch for equipment.
  - c. As required by authorities having jurisdiction.

## 2.4 BANDS AND TUBES

- A. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inch long, with diameters sized to suit diameters and that stay in place by gripping action.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. HellermannTyton.
    - c. Marking Services Inc.
    - d. Panduit Corp.
- B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at maximum of 200 deg F. Comply with UL 224.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. Panduit Corp.

## 2.5 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
  1. Manufacturers: Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
    - a. Champion America.
    - b. HellermannTyton.
    - c. Marking Services Inc.
    - d. Panduit Corp.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mil thick by 1 to 2 inch wide; compounded for outdoor use.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. Marking Services Inc.
- C. Tape and Stencil: 4 inch wide black stripes on 10 inch centers placed diagonally over orange background and are 12 inch wide. Stop stripes at legends.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. HellermannTyton.
  - b. Marking Services Inc.
  
- D. Floor Marking Tape: 2 inch wide, 5 mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Carlton Industries, LP.
    - b. Seton Identification Products; a Brady Corporation company.
  
- E. Underground-Line Warning Tape:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. Marking Services Inc.
  
  2. Tape:
    - a. Recommended by manufacturer for method of installation and suitable to identify and locate underground electrical and communications utility lines.
    - b. Printing on tape must be permanent and may not be damaged by burial operations.
    - c. Tape material and ink must be chemically inert and not be subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
  
  3. Color and Printing:
    - a. Comply with APWA Uniform Color Code using NEMA Z535.1 safety colors.
    - b. Inscriptions for Red Tapes: "CAUTION BURIED ELECTRIC LINE BELOW".
    - c. Inscriptions for Orange Tapes: "CAUTION BURIED CATV LINE BELOW", "CAUTION BURIED TELEPHONE LINE BELOW", "CAUTION BURIED FIBER OPTIC LINE BELOW", and "CAUTION BURIED COMMUNICATION LINE BELOW".
  
  4. Type I Tape:
    - a. Pigmented polyolefin, bright colored, continuous-printed on one side with inscription of utility, compounded for direct-burial service.
    - b. Width: 3 inch.
    - c. Thickness: 4 mil.
    - d. Weight: 18.5 lb/1000 sq. ft.
    - e. Tensile in accordance with ASTM D882: 30 lbf and 2500 psi.
  
  5. Type II Tape:

- a. Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored, continuous-printed on one side with inscription of utility, compounded for direct-burial service.
- b. Width: 3 inch.
- c. Thickness: 12 mil.
- d. Weight: 36.1 lb/1000 sq. ft.
- e. Tensile in accordance with ASTM D882: 400 lbf and 11,500 psi.

6. Type ID Tape:

- a. Detectable three-layer laminate, consisting of printed pigmented polyolefin film, solid aluminum-foil core, and clear protective film that allows inspection of continuity of conductive core; bright colored, continuous-printed on one side with inscription of utility, compounded for direct-burial service.
- b. Width: 3 inch.
- c. Overall Thickness: 5 mil.
- d. Foil Core Thickness: 0.35 mil.
- e. Weight: 28 lb/1000 sq. ft.
- f. Tensile in accordance with ASTM D882: 70 lbf and 4600 psi.

7. Type IID Tape:

- a. Reinforced, detectable three-layer laminate, consisting of printed pigmented woven scrim, solid aluminum-foil core, and clear protective film that allows inspection of continuity of conductive core; bright-colored, continuous-printed on one side with inscription of utility, compounded for direct-burial service.
- b. Width: 3 inch.
- c. Overall Thickness: 8 mil.
- d. Foil Core Thickness: 0.35 mil.
- e. Weight: 34 lb/1000 sq. ft.
- f. Tensile in accordance with ASTM D882: 300 lbf and 12,500 psi.

- F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height must be 1 inch.

2.6 TAGS

- A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Brady Corporation.
- b. Marking Services Inc.

- B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.023 inch thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Brady Corporation.
- b. Marking Services Inc.

- c. Panduit Corp.

C. Write-on Tags:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Carlton Industries, LP.
  - b. Seton Identification Products; a Brady Corporation company.
2. Polyester Tags: 0.015 inch thick, with corrosion-resistant grommet and cable tie for attachment.
3. Marker for Tags:
  - a. Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.7 SIGNS

A. Baked-Enamel Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Carlton Industries, LP.
  - b. Champion America.
  - c. Marking Services Inc.
2. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
3. 1/4 inch grommets in corners for mounting.
4. Nominal Size: 7 by 10 inch.

B. Metal-Backed Butyrate Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brady Corporation.
  - b. Champion America.
  - c. Marking Services Inc.
2. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396 inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
3. 1/4 inch grommets in corners for mounting.
4. Nominal Size: 10 by 14 inch.

C. Laminated Acrylic or Melamine Plastic Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brady Corporation.
  - b. Carlton Industries, LP.

- c. Marking Services Inc.
  - d. Seton Identification Products; a Brady Corporation company.
2. Engraved legend.
  3. Thickness:
    - a. For signs larger than 20 sq. inch, 1/8 inch thick.
    - b. Engraved legend with black letters on white face.
    - c. Self-adhesive.
    - d. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

## 2.8 CABLE TIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. HellermannTyton.
  2. Marking Services Inc.
  3. Panduit Corp.
- B. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
  1. Minimum Width: 3/16 inch.
  2. Tensile Strength at 73 deg F in accordance with ASTM D638: 12,000 psi.
  3. Temperature Range: Minus 40 to plus 185 deg F.
  4. Color: Black, except where used for color-coding.
- C. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
  1. Minimum Width: 3/16 inch.
  2. Tensile Strength at 73 deg F in accordance with ASTM D638: 12,000 psi.
  3. Temperature Range: Minus 40 to plus 185 deg F.
  4. Color: Black.
- D. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
  1. Minimum Width: 3/16 inch.
  2. Tensile Strength at 73 deg F in accordance with ASTM D638: 7000 psi.
  3. UL 94 Flame Rating: 94V-0.
  4. Temperature Range: Minus 50 to plus 284 deg F.
  5. Color: Black.

## 2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless steel screws or stainless steel machine screws with nuts and flat and lock washers.



## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

### 3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. System Identification for Raceways and Cables under 1000 V: Identification must completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
  - 1. Secure tight to surface of conductor, cable, or raceway.
- H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- I. Emergency Operating Instruction Signs: Install instruction signs with white legend on red background with minimum 3/8 inch high letters for emergency instructions at equipment used for power transfer.
- J. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from floor.
- K. Accessible Fittings for Raceways: Identify cover of junction and pull box of the following systems with wiring system legend and system voltage. System legends must be as follows:
  - 1. "EMERGENCY POWER."
  - 2. "POWER."
- L. Vinyl Wraparound Labels:
  - 1. Secure tight to surface of raceway or cable at location with high visibility and accessibility.
  - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to location and substrate.
- M. Snap-Around Labels: Secure tight to surface at location with high visibility and accessibility.

- N. Self-Adhesive Wraparound Labels: Secure tight to surface at location with high visibility and accessibility.
- O. Self-Adhesive Labels:
  - 1. Install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
  - 2. Unless otherwise indicated, provide single line of text with 1/2 inch high letters on 1-1/2 inch high label; where two lines of text are required, use labels 2 inch high.
- P. Snap-Around Color-Coding Bands: Secure tight to surface at location with high visibility and accessibility.
- Q. Heat-Shrink, Preprinted Tubes: Secure tight to surface at location with high visibility and accessibility.
- R. Marker Tapes: Secure tight to surface at location with high visibility and accessibility.
- S. Self-Adhesive Vinyl Tape: Secure tight to surface at location with high visibility and accessibility.
  - 1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for minimum distance of 6 inch where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- T. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- U. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's instructions.
- V. Underground Line Warning Tape:
  - 1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inch below finished grade. Use multiple tapes where width of multiple lines installed in common trench or concrete envelope exceeds 16 inch overall.
  - 2. Install underground-line warning tape for direct-buried cables and cables in raceways.
- W. Metal Tags:
  - 1. Place in location with high visibility and accessibility.
  - 2. Secure using UV-stabilized cable ties.
- X. Nonmetallic Preprinted Tags:
  - 1. Place in location with high visibility and accessibility.
  - 2. Secure using UV-stabilized cable ties.
- Y. Write-on Tags:
  - 1. Place in location with high visibility and accessibility.
  - 2. Secure using UV-stabilized cable ties.
- Z. Baked-Enamel Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
2. Unless otherwise indicated, provide single line of text with 1/2 inch high letters on minimum 1-1/2 inch high sign; where two lines of text are required, use signs minimum 2 inch high.

AA. Metal-Backed Butyrate Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
2. Unless otherwise indicated, provide single line of text with 1/2 inch high letters on 1-1/2 inch high sign; where two lines of text are required, use labels 2 inch high.

BB. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
2. Unless otherwise indicated, provide single line of text with 1/2 inch high letters on 1-1/2 inch high sign; where two lines of text are required, use labels 2 inch high.

CC. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

### 3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Concealed Raceways, Duct Banks, More Than 1000 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with 3 inch high, black letters on 20 inch centers.
  1. Locate identification at changes in direction, at penetrations of walls and floors, and at 10 ft maximum intervals.
- D. Accessible Raceways and Metal-Clad Cables, 1000 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels.
  1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft maximum intervals in straight runs, and at 25 ft maximum intervals in congested areas.
- E. Accessible Fittings for Raceways and Cables within Buildings: Identify cover of junction and pull box of the following systems with self-adhesive labels containing wiring system legend and system voltage. System legends must be as follows:
  1. "EMERGENCY POWER."
  2. "POWER."

- F. Power-Circuit Conductor Identification, 1000 V or Less: For conductors in pull and junction boxes, use self-adhesive vinyl tape to identify phase.
  - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft maximum intervals in straight runs, and at 25 ft maximum intervals in congested areas.
- G. Power-Circuit Conductor Identification, More Than 1000 V: For conductors in pull and junction boxes, use nonmetallic preprinted tags colored and marked to indicate phase, and separate tag with circuit designation.
- H. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, use self-adhesive labels with conductor or cable designation, origin, and destination.
- I. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes with conductor designation.
- J. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- K. Concealed Raceways and Duct Banks, More Than 1000 V, within Buildings: Apply floor marking tape to the following finished surfaces:
  - 1. Floor surface directly above conduits running beneath and within 12 inch of floor that is in contact with earth or is framed above unexcavated space.
  - 2. Wall surfaces directly external to raceways concealed within wall.
  - 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in building, or concealed above suspended ceilings.
- L. Workspace Indication: Apply floor marking tape or tape and stencil to finished surfaces. Show working clearances in direction of access to live parts. Workspace must comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- M. Instructional Signs: Self-adhesive labels, including color code for grounded and ungrounded conductors.
- N. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs.
  - 1. Apply to exterior of door, cover, or other access.
  - 2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
    - a. Power-transfer switches.
    - b. Controls with external control power connections.
- O. Arc Flash Warning Labeling: Self-adhesive labels.
- P. Operating Instruction Signs: Baked-enamel warning signs.
- Q. Emergency Operating Instruction Signs: Baked-enamel warning signs with white legend on red background with minimum 3/8 inch high letters for emergency instructions at equipment used for power transfer.
- R. Equipment Identification Labels:

1. Indoor Equipment: Baked-enamel signs.
2. Outdoor Equipment: Stenciled legend 4 inch high.
3. Equipment to Be Labeled:
  - a. Panelboards: Typewritten directory of circuits in location provided by panelboard manufacturer. Panelboard identification must be in form of engraved, laminated acrylic or melamine label.
  - b. Enclosures and electrical cabinets.
  - c. Access doors and panels for concealed electrical items.
  - d. Switchboards.
  - e. Transformers: Label that includes tag designation indicated on Drawings for transformer, feeder, and panelboards or equipment supplied by secondary.
  - f. Emergency system boxes and enclosures.
  - g. Enclosed switches.
  - h. Enclosed circuit breakers.
  - i. Enclosed controllers.
  - j. Variable-speed controllers.
  - k. Push-button stations.
  - l. Power-transfer equipment.
  - m. Contactors.
  - n. Remote-controlled switches, dimmer modules, and control devices.
  - o. Monitoring and control equipment.

END OF SECTION

## SECTION 260573.13

### SHORT-CIRCUIT STUDIES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

###### A. Section Includes:

- 1. Computer-based, fault-current study to determine minimum interrupting capacity of circuit protective devices.

###### B. Related Requirements:

- 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.
- 2. Section 260573.16 "Coordination Studies" for overcurrent protective device coordination studies.
- 3. Section 260573.19 "Arc-Flash Hazard Analysis" for arc-flash studies.

##### 1.3 DEFINITIONS

- A. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- B. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.
- C. SCCR: Short-circuit current rating.
- D. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- E. Single-Line Diagram: See "One-Line Diagram."

##### 1.4 ACTION SUBMITTALS

###### A. Product Data:

- 1. For power system analysis software to be used for studies.

###### B. Short-Circuit Study Report:

- 1. Submit the following after approval of system protective devices submittals. Submittals must be in digital form.

- a. Short-circuit study input data, including completed computer program input data sheets.
- b. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
- c. Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

#### 1.6 QUALITY ASSURANCE

- A. Study must be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms must comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.

### PART 2 - PRODUCTS

#### 2.1 POWER SYSTEM ANALYSIS SOFTWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. CGI CYME.
  2. EasyPower, LLC (formerly ESA Inc.).
  3. EDSA Micro Corporation.
  4. ESA Inc.
  5. ETAP - Digital Twin Platform.
  6. Power Analytics, Corporation.
  7. SKM Systems Analysis, Inc.
- B. Comply with IEEE 399 and IEEE 551.
- C. Analytical features of power systems analysis software program must have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer software program must be capable of plotting and diagramming time-current-characteristic curves as part of its output.
- E. Computer program must be designed to perform short-circuit studies or have function, component, or add-on module designed to perform short-circuit studies.
- F. Computer program must be developed under supervision of licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

## 2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram of modeled power system, showing the following:
  - 1. Protective device designations and ampere ratings.
  - 2. Conductor types, sizes, and lengths.
  - 3. Transformer kVA and voltage ratings.
  - 4. Motor and generator designations and kVA ratings.
  - 5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
  - 6. Derating factors and environmental conditions.
  - 7. Any revisions to electrical equipment required by study.
- D. Comments and recommendations for system improvements or revisions in written document, separate from one-line diagram.
- E. Protective Device Evaluation:
  - 1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.
  - 2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
  - 3. For 600 V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
  - 4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
  - 5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
- F. Short-Circuit Study Input Data:
  - 1. One-line diagram of system being studied.
  - 2. Power sources available.
  - 3. Manufacturer, model, and interrupting rating of protective devices.
  - 4. Conductors.
  - 5. Transformer data.
- G. Short-Circuit Study Output Reports:
  - 1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
    - a. Voltage.
    - b. Calculated fault-current magnitude and angle.
    - c. Fault-point X/R ratio.
    - d. Equivalent impedance.



2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
  - a. Voltage.
  - b. Calculated symmetrical fault-current magnitude and angle.
  - c. Fault-point X/R ratio.
  - d. Calculated asymmetrical fault currents:
    - 1) Based on fault-point X/R ratio.
    - 2) Based on calculated symmetrical value multiplied by 1.6.
    - 3) Based on calculated symmetrical value multiplied by 2.7.
  
3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
  - a. Voltage.
  - b. Calculated symmetrical fault-current magnitude and angle.
  - c. Fault-point X/R ratio.
  - d. No AC Decrement (NACD) ratio.
  - e. Equivalent impedance.
  - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.
  - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.

### PART 3 - EXECUTION

#### 3.1 POWER SYSTEM DATA

- A. Obtain data necessary for conduct of study.
  1. Verify completeness of data supplied on one-line diagram. Call discrepancies to Architect's attention.
  2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
  
- B. Gather and tabulate required input data to support short-circuit study. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to amount of detail that is required to be acquired in field. Field data gathering must be by, or under supervision of, qualified electrical professional engineer. Data includes, but are not limited to, the following:
  1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
  2. Obtain electrical power utility impedance at service.
  3. Power sources and ties.
  4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
  5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
  6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.

7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
9. Motor horsepower and NEMA MG 1 code letter designation.
10. Conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
11. Derating factors.

### 3.2 SHORT-CIRCUIT STUDY

- A. Perform study following general study procedures contained in IEEE 399.
- B. Calculate short-circuit currents according to IEEE 551.
- C. Base study on device characteristics supplied by device manufacturer.
- D. Extent of electrical power system to be studied is indicated on Drawings.
- E. Begin short-circuit current analysis at service, extending down to system overcurrent protective devices as follows:
  1. To normal system low-voltage load buses where fault current is 5 kA or less.
  2. Exclude equipment supplied by single transformer smaller than 75 kVA.
- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. Include ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement to address asymmetrical requirements of interrupting equipment.
- H. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at each equipment indicated on one-line diagram.
  1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.
- I. Include in report identification of protective device applied outside its capacity.

END OF SECTION

## SECTION 260573.16

### COORDINATION STUDIES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

###### A. Section Includes:

- 1. Computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.
  - a. Study results must be used to determine coordination of series-rated devices.

###### B. Related Requirements:

- 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.
- 2. Section 260573.13 "Short-Circuit Studies" for fault-current studies.
- 3. Section 260573.19 "Arc-Flash Hazard Analysis" for arc-flash studies.

##### 1.3 DEFINITIONS

- A. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of electric circuit or system of circuits and the component devices or parts used therein.
- B. Protective Device: A device that senses when abnormal current flow exists and then removes the affected portion of the circuit from the system.
- C. SCCR: Short-circuit current rating.
- D. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- E. Single-Line Diagram: See "One-Line Diagram."

##### 1.4 ACTION SUBMITTALS

###### A. Product Data:

- 1. For power system analysis software to be used for studies.

###### B. Coordination Study Report:

1. Submit the following after approval of system protective devices submittals. Submittals **must** be in digital form.
  - a. Coordination-study input data, including completed computer program input data sheets.
  - b. Study and equipment evaluation reports.
  - c. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
  - d. Revised one-line diagram, reflecting field investigation results and results of coordination study.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

#### 1.6 QUALITY ASSURANCE

- A. Studies must be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms must comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.

#### 1.7 REGULATORY AGENCY APPROVALS

- A. Submittals for coordination study requiring approval by authorities having jurisdiction must be signed and sealed by qualified electrical professional engineer responsible for their preparation. Obtain approval by authorities having jurisdiction prior to submitting for action by Architect.
- B. Submittals for coordination study require action by Architect prior to submitting for approval by authorities having jurisdiction.

### PART 2 - PRODUCTS

#### 2.1 POWER SYSTEM ANALYSIS SOFTWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. CGI CYME.
  2. EasyPower, LLC (formerly ESA Inc.).
  3. EDSA Micro Corporation.
  4. ESA Inc.
  5. ETAP - Digital Twin Platform.
  6. Power Analytics, Corporation.
  7. SKM Systems Analysis, Inc.
- B. Comply with IEEE 242 and IEEE 399.

- C. Analytical features of device coordination study computer software program must have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer software program must be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program must report device settings and ratings of overcurrent protective devices and must demonstrate selective coordination by computer-generated, time-current coordination plots.
  - 1. Optional Features:
    - a. Arcing faults.
    - b. Simultaneous faults.
    - c. Explicit negative sequence.
    - d. Mutual coupling in zero sequence.
- E. Computer program must be designed to perform coordination studies or have function, component, or add-on module designed to perform coordination studies.
- F. Computer program must be developed under supervision of licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

## 2.2 COORDINATION STUDY REPORT CONTENTS

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram of modeled power system, showing the following:
  - 1. Protective device designations and ampere ratings.
  - 2. Conductor types, sizes, and lengths.
  - 3. Transformer kVA and voltage ratings.
  - 4. Motor and generator designations and kVA ratings.
  - 5. Switchgear, switchboard, motor-control center, and panelboard designations.
  - 6. Revisions to electrical equipment required by study.
  - 7. Study Input Data: As described in "Power System Data" Article.
    - a. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
- D. Protective Device Coordination Study:
  - 1. Report recommended settings of protective devices, ready to be applied in field. Use manufacturer's data sheets for recording recommended setting of overcurrent protective devices when available.
    - a. Phase and Ground Relays:
      - 1) Device tag.
      - 2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
      - 3) Recommendations on improved relaying systems, if applicable.

- b. Circuit Breakers:
    - 1) Adjustable pickups and time delays (long time, short time, and ground).
    - 2) Adjustable time-current characteristic.
    - 3) Adjustable instantaneous pickup.
    - 4) Recommendations on improved trip systems, if applicable.
  - c. Fuses: Show current rating, voltage, and class.
- E. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for switching schemes and for emergency periods where power source is local generation. Show the following information:
1. Device tag and title, one-line diagram with legend identifying portion of system covered.
  2. Terminate device characteristic curves at point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
  3. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
  4. Plot the following listed characteristic curves, as applicable:
    - a. Low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
    - b. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
    - c. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
    - d. Cables and conductors damage curves.
    - e. Ground-fault protective devices.
    - f. Motor-starting characteristics and motor damage points.
    - g. Generator short-circuit decrement curve and generator damage point.
    - h. Largest feeder circuit breaker in each motor-control center and panelboard.
  5. Maintain selectivity for tripping currents caused by overloads.
  6. Provide adequate time margins between device characteristics such that selective operation is achieved.
  7. Comments and recommendations for system improvements.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.
  1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

#### 3.2 POWER SYSTEM DATA

- A. Obtain data necessary for conduct of overcurrent protective device study.

1. Verify completeness of data supplied in one-line diagram on Drawings. Call discrepancies to Architect's attention.
  2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
- B. Gather and tabulate required input data to support coordination study. List below is guide. Comply with recommendations in IEEE 551 for amount of detail required to be acquired in field. Field data gathering must be by, or under supervision of, qualified electrical professional engineer. Data includes, but are not limited to, the following:
1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
  2. Electrical power utility impedance at service.
  3. Power sources and ties.
  4. Short-circuit current at each system bus (three phase and line to ground).
  5. Full-load current of loads.
  6. Voltage level at each bus.
  7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
  8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
  9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
  10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
  11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
  12. Maximum demands from service meters.
  13. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
  14. Motor horsepower and NEMA MG 1 code letter designation.
  15. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
  16. Data sheets to supplement electrical distribution system one-line diagram, cross-referenced with tag numbers on diagram, showing the following:
    - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    - d. Generator thermal-damage curve.
    - e. Ratings, types, and settings of utility company's overcurrent protective devices.
    - f. Special overcurrent protective device settings or types stipulated by utility company.
    - g. Time-current-characteristic curves of devices indicated to be coordinated.
    - h. Manufacturer, frame size, interrupting rating in amperes root mean square (rms) symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
    - i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

- j. Switchboards and panelboards ampacity, and SCCR in amperes rms symmetrical.

### 3.3 COORDINATION STUDY

- A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.
- B. Comply with IEEE 399 for general study procedures.
- C. Base study on device characteristics supplied by device manufacturer.
- D. Extent of electrical power system to be studied is indicated on Drawings.
- E. Begin analysis at service, extending down to system overcurrent protective devices as follows:
  - 1. To normal system low-voltage load buses where fault current is 5 kA or less.
  - 2. Exclude equipment supplied by single transformer smaller than 75 kVA.
- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. Transformer Primary Overcurrent Protective Devices:
  - 1. Device must not operate in response to the following:
    - a. Inrush current when first energized.
    - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
    - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
  - 2. Device settings must protect transformers according to IEEE C57.12.00, for fault currents.
- H. Motor Protection:
  - 1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
  - 2. Select protection for motors served at voltages more than 600 V according to IEEE 620.
- I. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands maximum short-circuit current for time equivalent to tripping time of primary relay protection or total clearing time of fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- J. Generator Protection: Select protection according to manufacturer's instructions and to IEEE 242.
- K. Include ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement, to address asymmetrical requirements of interrupting equipment.



- L. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at each equipment indicated on one-line diagram.
  - 1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.

M. Protective Device Evaluation:

- 1. Evaluate equipment and protective devices and compare to short-circuit ratings.
- 2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
- 3. Include in report identification of protective device applied outside its capacity.

3.4 LOAD-FLOW AND VOLTAGE-DROP STUDY

- A. Perform load-flow and voltage-drop study to determine steady-state loading profile of system. Analyze power system performance two times as follows:
  - 1. Determine load flow and voltage drop based on full-load currents obtained in "Power System Data" Article.
  - 2. Determine load flow and voltage drop based on 80 percent of design capacity of load buses.
  - 3. Prepare load-flow and voltage-drop analysis and report to show power system components that are overloaded or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.5 MOTOR-STARTING STUDY

- A. Perform motor-starting study to analyze transient effect of system's voltage profile during motor starting. Calculate significant motor-starting voltage profiles and analyze effects of motor starting on power system stability.
- B. Prepare motor-starting study report, noting light flicker for limits proposed by IEEE 141, and voltage sags so as not to affect operation of other utilization equipment on system supplying motor.

3.6 FIELD ADJUSTING

- A. Adjust relay and protective device settings according to recommended settings provided by coordination study. Field adjustments must be completed by engineering service division of equipment manufacturer under "Startup and Acceptance Testing" contract portion.
- B. Make minor modifications to equipment as required to accomplish compliance with **short-circuit and** protective device coordination studies.
- C. Testing and adjusting must be by qualified low-voltage electrical testing and inspecting agency.
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for adjustable overcurrent protective devices.

END OF SECTION

## SECTION 260573.19

### ARC-FLASH HAZARD ANALYSIS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

###### A. Section Includes:

- 1. Computer-based, arc-flash study to determine arc-flash hazard distance and incident energy to which personnel could be exposed during work on or near electrical equipment.

###### B. Related Requirements:

- 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.
- 2. Section 260573.13 "Short-Circuit Studies" for fault-current studies.
- 3. Section 260573.16 "Coordination Studies" for overcurrent protective device coordination studies.

##### 1.3 DEFINITIONS

- A. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- B. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- C. p.u.: Per unit. The reference unit, established as a calculating convenience, for expressing all power system electrical parameters on a common reference base.
- D. SCCR: Short-circuit current rating.
- E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- F. Single-Line Diagram: See "One-Line Diagram."

##### 1.4 ACTION SUBMITTALS

###### A. Product Data:

- 1. For power system analysis software to be used for studies.

###### B. Study Submittals:

1. Submit the following after approval of system protective devices submittals. Submittals must be in digital form:
  - a. Arc-flash study input data, including completed computer program input data sheets.
  - b. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
  - c. Revised one-line diagram, reflecting field investigation results and results of arc-flash study.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

#### 1.6 QUALITY ASSURANCE

- A. Study must be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms must comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.

#### 1.7 REGULATORY AGENCY APPROVALS

- A. Submittals for arc-flash hazard analysis requiring approval by authorities having jurisdiction must be signed and sealed by qualified electrical professional engineer responsible for their preparation. [Obtain approval by authorities having jurisdiction prior to submitting for action by Architect.] [Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.]
- B. Submittals for arc-flash hazard analysis require action by Architect prior to submitting for approval by authorities having jurisdiction.

### PART 2 - PRODUCTS

#### 2.1 COMPUTER SOFTWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. CGI CYME.
  2. EasyPower, LLC (formerly ESA Inc.).
  3. EDSA Micro Corporation.
  4. ESA Inc.
  5. ETAP - Digital Twin Platform.
  6. Power Analytics, Corporation.
  7. SKM Systems Analysis, Inc.
- B. Comply with IEEE 1584 and NFPA 70E.

- C. Analytical features of device coordination study computer software program must have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer program must be designed to perform arc-flash analysis or have function, component, or add-on module designed to perform arc-flash analysis.
- E. Computer program must be developed under supervision of licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

## 2.2 ARC-FLASH STUDY REPORT CONTENT

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram, showing the following:
  - 1. Protective device designations and ampere ratings.
  - 2. Conductor types, sizes, and lengths.
  - 3. Transformer kVA and voltage ratings, including derating factors and environmental conditions.
  - 4. Motor and generator designations and kVA ratings.
  - 5. Switchboard, panelboard designations, and ratings.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
- F. Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."
- G. Arc-Flash Study Output Reports:
  - 1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in report:
    - a. Voltage.
    - b. Calculated symmetrical fault-current magnitude and angle.
    - c. Fault-point X/R ratio.
    - d. No AC Decrement (NACD) ratio.
    - e. Equivalent impedance.
    - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.
    - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.
- H. Incident Energy and Flash Protection Boundary Calculations:
  - 1. Arcing fault magnitude.
  - 2. Protective device clearing time.
  - 3. Duration of arc.
  - 4. Arc-flash boundary.
  - 5. Restricted approach boundary.

6. Limited approach boundary.
7. Working distance.
8. Incident energy.
9. Hazard risk category.
10. Recommendations for arc-flash energy reduction.

- I. Fault study input data, case descriptions, and fault-current calculations including definition of terms and guide for interpretation of computer printout.

### 2.3 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce 3.5 by 5 inch self-adhesive equipment label for each work location included in analysis.
- B. Label must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from arc-flash hazard analysis:
  1. Location designation.
  2. Nominal voltage.
  3. Protection boundaries.
    - a. Arc-flash boundary.
    - b. Restricted approach boundary.
    - c. Limited approach boundary.
  4. Arc flash PPE category.
  5. Required minimum arc rating of PPE in Cal/cm squared.
  6. Available incident energy.
  7. Working distance.
  8. Engineering report number, revision number, and issue date.
- C. Labels must be machine printed, with no field-applied markings.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

### 3.2 ARC-FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Preparatory Studies: Perform Short-Circuit and Protective Device Coordination study studies prior to starting Arc-Flash Hazard Analysis or obtain results from another source.
  1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
  2. Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."

- C. Calculate maximum and minimum contributions of fault-current size.
  - 1. Maximum calculation must assume maximum contribution from utility and must assume motors to be operating under full-load conditions.
  - 2. Calculate arc-flash energy at 85 percent of maximum short-circuit current in accordance with IEEE 1584 recommendations.
  - 3. Calculate arc-flash energy at 38 percent of maximum short-circuit current in accordance with NFPA 70E recommendations.
  - 4. Calculate arc-flash energy with utility contribution at minimum and assume no motor contribution.
- D. Calculate arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.
- E. Include low-voltage equipment locations, except equipment fed from transformers smaller than 75 kVA.
- F. Calculate limited, restricted, and prohibited approach boundaries for each location.
- G. Incident energy calculations must consider accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations must take into account changing current contributions, as sources are interrupted or decremented with time. Fault contribution from motors and generators must be decremented as follows:
  - 1. Fault contribution from induction motors must not be considered beyond three to five cycles.
  - 2. Fault contribution from synchronous motors and generators must be decayed to match actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 p.u. to 3 p.u. after 10 cycles).
- H. Arc-flash energy must generally be reported for maximum of line or load side of circuit breaker. However, arc-flash computation must be performed and reported for both line and load side of circuit breaker as follows:
  - 1. When circuit breaker is in separate enclosure.
  - 2. When line terminals of circuit breaker are separate from work location.
- I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

### 3.3 POWER SYSTEM DATA

- A. Obtain data necessary for conduct of arc-flash hazard analysis.
  - 1. Verify completeness of data supplied on one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to Architect's attention.
  - 2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.
  - 3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys conducted by qualified technicians and engineers.
- B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to amount of detail that is required to be

acquired in field. Field data gathering must be under direct supervision and control of engineer in charge of performing study, and must be by, or under supervision of, qualified electrical professional engineer. Data includes, but are not limited to, the following:

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance or available short circuit current at service.
3. Power sources and ties.
4. Short-circuit current at each system bus (three phase and line to ground).
5. Full-load current of loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

### 3.4 LABELING

- A. Apply one arc-flash label on front cover of each section of equipment and hinged doors or removable plates for each equipment included in study. Base arc-flash label data on highest values calculated at each location.
- B. Each piece of equipment listed below not fed by single transformer smaller than 75 kVA must have arc-flash label applied to it:
  1. Switchboards.
  2. Panelboards.
  3. Low voltage transformers.
  4. Safety switches.
  5. Control panels.
- C. Note on record Drawing's location of equipment where personnel could be exposed to arc-flash hazard during their work.
  1. Indicate arc-flash energy.
  2. Indicate protection level required.

3.5 APPLICATION OF WARNING LABELS

- A. Install arc-flash warning labels under direct supervision and control of qualified electrical professional engineer.

END OF SECTION



SECTION 260800  
COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 DESCRIPTION

- A. General provisions and other electrical systems are specified in other Sections of Division 26.
- B. Commissioning is an ongoing process and shall be performed throughout construction. Commissioning requires the participation of Division 26 to ensure that all systems are operating in a manner consistent with the Contract Documents. Division 26 shall be familiar with the commissioning plan issued by the CA as it applies to the work of Division 26 and shall execute all commissioning responsibilities assigned to them in the Contract Documents. The contractors should also review Specifications Section 019113 for additional information.
- C. Commissioning shall conclude with the completion of all required deferred testing, training and system documentation as specified and required to demonstrate the proper operation of the electrical equipment and systems provided by this Division.
- D. This Section covers electrical systems commissioning, as required to demonstrate that the equipment and systems of Division 26 are ready for safe and satisfactory operation, as defined by project documents. Commissioning shall include, but shall not be limited to, identification, cleaning, documentation, preparation of maintenance and operation manuals, Owner training, preparation of record drawings, lubrication, start-up, check-out, and testing and adjusting of systems.
- E. This section does not alter the commissioning requirements indicated in Division 26 of the building specifications. This section is to help define/supplement the requirements where applicable.

1.4 QUALITY ASSURANCE

- A. The electrical contractor and the fire alarm contractor shall identify an electrical and fire alarm commissioning supervisor. The commissioning supervisors should have a minimum of ten years experience in electrical contracting. The electrical commissioning supervisors shall become familiar with the design intent, the requirements of the commissioning process as defined in this Section. Electrical systems and Fire Alarm commissioning shall be accomplished under supervision of the Commissioning Agent (CA). The electrical commissioning supervisor shall assist the CA in coordinating and executing the required commissioning activities.

## 1.5 ELECTRICAL COMMISSIONING RESPONSIBILITIES

- B. Include and itemize the cost of commissioning in the contract price with an estimated breakdown of hours for meeting and functional testing requirements.
- C. The electrical commissioning supervisor shall be responsible for scheduling, supervising, and coordinating the startup, testing, and commissioning activities as specified herein with the CA. Specific requirements of the electrical contractor and associated subcontractors are identified in this Section and in other Sections of this Division.
- D. The CA shall conduct independent verification of installation, pre-functional, start-up and functional testing as per section 019113.
- E. Electrical commissioning shall take place in three phases. Commissioning requirements for each phase are as follows:
  - 1. Construction Phase
    - a. Contractor shall attend a Commissioning Scoping meeting and additional commissioning meetings as required throughout the commissioning process. These commissioning meetings will be monthly during early construction and increase in frequency to weekly during the start-up, prefunctional and functional testing phases. Contractor shall assure that all subcontractors who have commissioning responsibilities attend the Commissioning Scoping meeting and other commissioning meetings, as appropriate, during the construction process.
    - b. Contractor shall report in writing to the CA at least as often as commissioning meetings are scheduled concerning the status of his activities as they affect the commissioning process, the status of each discrepancy identified, the prefunctional and functional testing process, explanations of any disagreements with the identified deficiencies, and proposed resolution and schedule.
    - c. Contractor shall provide the CA with normal cut sheets and shop drawing submittals of equipment that is to be commissioned.
    - d. Contractor shall provide documentation to the CA for development of pre-functional and functional performance testing procedures, prior to normal O&M manual submittals. This documentation shall include detailed manufacturer installation, start-up, operating, troubleshooting and maintenance procedures; full details of any owner-contracted tests; fan and pump curves; full factory testing reports, if any; and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation, start-up, and checkout materials that are shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Agent. The Commissioning Agent may request further documentation necessary for the development of functional performance testing and the commissioning process. This data request may be made prior to normal submittals.
    - e. Contractor shall develop and submit to CA, for review prior to equipment or system startup, a complete startup and initial checkout plan using manufacturer's start-up procedures. The commissioning agent shall conduct their own pre-functional testing check in parallel with the contractors.

- f. Contractor shall review the commissioning agent's pre-functional check sheets and sign-off on the appropriate areas when contractor and sub-contractors are complete. The prefunctional test sheets will be developed by the commissioning agent. Only when each portion of the pre-functional test sheet is signed off will the contractor be able to move onto the next phase of the start-up and check-out. Detailed in Specification Section 019113, 2.1 "Overview Sign-Off Sheet"
- g. Contractor shall provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, to the CA for review.
- h. Contractor shall assist in clarifying the proposed operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
- i. CA shall prepare the specific functional test procedures as specified herein. The contractors shall review the CA's proposed functional performance test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
- j. Commissioning agent shall prepare a preliminary schedule for Division 26 commissioning activities, to include, equipment start-up, for use by the CA and shall update the schedule as appropriate. The contractor shall notify the commissioning agent who shall update the commissioning activities and notify any delays in the progress meetings. Contractor shall notify the CA during the commissioning meetings when commissioning activities not yet performed or not yet scheduled will delay construction.
- k. Electrical equipment start-up shall not be initiated until the complete sign-off of the pre-functional check-sheets as developed by the commissioning agent as specified in other Sections of Division 26.
- l. Contractor shall provide startup testing for all electrical equipment, including the power supply for the building automation control system and shall execute the fire alarm-related portions for all commissioned equipment during the startup and initial checkout process. The commissioning agent shall conduct an independent start-up once the contractor is complete with their requirements. The commissioning agent shall conduct an independent prefunctional check once the contractor states that they are complete with the system installation.
- m. Contractor shall perform and clearly document all completed startup and system operational checkout procedures as part of their existing contract, providing a copy to the CA.
- n. Contractor shall correct current A/E punch list and CA deficiency items before functional performance testing can begin. The contractor's required testing and start-up shall be completed with discrepancies and problems remedied before functional testing of the respective systems.
- o. The commissioning agent shall generate the functional testing procedure and record to the electrical contractor. The electrical contractor shall review and provide support to the functional testing process. Contractor shall operate chillers, pumps, etc and systems in accordance with the CA requirements, open and closes disconnects and switch normal and emergency power requirements as directed by the commissioning agent and the functional testing procedures.
- p. Contractor shall report in writing to the CA at least as often as commissioning meetings are being scheduled concerning the status of each outstanding discrepancy identified during commissioning, prefunctional and functional performance testing. Report shall include description of the identified discrepancy, explanations of any disagreements, and proposals and schedule for correction of the discrepancy.

2. Acceptance Phase. Contractor shall assist and cooperate with the CA in the commissioning process by:
  - a. Putting all equipment and systems into operation and continuing the operation during each working day of the test and balance and commissioning effort, as required.
  - b. Commissioning agent shall witness independent verification of megger and insulation testing. CA shall also test each of the receptacles and lighting controls systems in accordance with the specifications. This independent testing does not relieve the contractor from their responsibilities as set forth in the specification. The electrical contractor shall provide representative to assist the CA on conducting checks of the electrical components.
  - c. Providing skilled technicians to execute starting and operation of equipment.
  - d. The commissioning agent shall witness an independent verification of the insulation resistance testing. This does not relieve the contractor from their responsibilities in regard to the specifications. The electrical contractor shall provide skilled technicians to aid in this testing requirement.
  - e. The commissioning agent will conduct functional performance testing. The contractor may be required to have a skilled technician present during functional testing although it is suggested that one be available to make adjustments or assist in problem-solving.
  - f. The commissioning will require full and part load performance verifications as well as seasonal and simulated testing requirements. The contractor shall be prepared to operate different components of various systems (example, generator load testing) during the functional testing.
  - g. Correct deficiencies (differences between specified and observed performance) as interpreted by the CA and A/E.
  - h. Prepare O&M manuals according to the Contractor Documents, including clarifying and updating the original sequence of operation to as-built conditions.
  - i. Maintain on site redline as built drawings and produce final "As-built" drawings for all project drawings and contractor-generated coordination drawings. List and clearly identify on the as-built drawings the locations of all ATS and sensor installations that are not equipment mounted.
  - j. Provide specified training of the Owner's operating personnel in accordance with the commissioning agent's overview and outline.
  - k. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
  - l. The commissioning agent will verify emergency power and automatic transfer switch devices. This shall include blackout testing as well as light level verification and emergency power verification testing. This does not relieve the contractor from their required testing requirements as directed in the specification. The contractor shall provide manpower to aid in the system testing and verification requirements.
  - m. Provide updated wiring diagrams for all systems involved in the commissioning process.
3. Warranty Period. During the warranty period, the contractor shall:
  - a. Be available during seasonal or deferred functional performance testing conducted by the CA, according to the specifications.
  - b. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

## PART 2 - PRODUCTS

### 2.1 SYSTEMS TO BE COMMISSIONED

- A. The following are systems to be commissioned.
  - 1. Lighting Controls including Site Lighting
  - 2. Electrical System Blackout Testing, including Egress Lighting
  - 3. Emergency Generator Systems
  - 4. Communication Systems
  - 5. Safety and Security Systems
  - 6. Fire-Alarm Systems

## 2.2 TEST EQUIPMENT

- A. All standard testing equipment required to the electrical portion startup, initial checkout shall be provided by the contractor responsible for the equipment or system being tested. This includes fire alarm and controls verification.
- B. The commissioning agent shall perform their own system verification and performance check-out. The commissioning agent shall provide their own calibrated equipment as required for this testing.
- C. Special equipment, tools and instruments as specified in the general specifications (only available from vendor or specific to a piece of equipment) required for the functional testing of that equipment, according to the requirements of the contract documents and the functional test procedures shall be provided to the CA by the installing contractor and shall become the property of the Owner at project completion.

## PART 3 - EXECUTION

### 3.1 SUBMITALS

- A. Division 26 shall provide submittal documentation relative to commissioning to the CA as requested by the CA.

### 3.2 STARTUP AND PREFUNCTIONAL TESTING

- A. The electrical contractor and associated subcontractors shall be responsible for the installation of complete systems and sub-systems, fully functional, meeting the design objectives of the Contract Documents. Contractor shall follow the approved start-up, checkout procedures. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning agent or Owner.
- B. Prefunctional testing shall be required for each piece of equipment to ensure that the equipment and systems are professionally installed and ready for operation, so that functional performance testing may proceed without delays. Sampling strategies shall not be used for prefunctional testing. The prefunctional testing for all equipment and subsystems of a given system shall be successfully completed and documented prior to functional performance testing of the system. The commissioning agent shall conduct an independent prefunctional verification. Only when the prefunctional checkout is approved and signed by all parties responsible, shall functional testing commence.
- C. The following procedures shall apply to all equipment and systems to be commissioned.
  - 1. Start-up and Initial Checkout Plan. The Commissioning Agent shall develop the detailed start-up and prefunctional testing plans for all equipment. The primary role of the CA in this process shall be to review the installation for construction completeness and ensure that all components have been installed as per the

design documents. Only when pre-functional testing is complete and signed off by all contractors, shall the equipment be start-up by the contractor. Equipment and systems to be commissioned are identified in this Section Part 2. The prefunctional testing checkout requirements shall be provided to the contractors for their review and use.

2. The start-up and initial checkout plan shall consist of the following as a minimum:
    - a. The manufacturer's standard written start-up and checkout procedures copied from the installation manuals and manufacturer's normally used field checkout sheets. The plan shall include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.
    - b. First-run checklist for equipment, to include:
      - 1) Equipment properly set.
      - 2) Wiring and conduits installed as per document
      - 3) Initial checkout and testing of electrical settings
      - 4) Checkout of lighting and power requirements
      - 5) Electrical equipment installation and code requirements
      - 6) Wiring properly connected.
      - 7) Electrical overload relays appropriate for load.
      - 8) Electrical accessories professionally installed and adjusted.
      - 9) Controls, safeties, and time switches properly set
      - 10) Verification of emergency power systems and components
      - 11) Measurements of ampere draw of electric motors and comparison with nameplate rating and with overload heater ratings.
      - 12) Monitoring of temperature build-up in motors and bearings.
  3. The Commissioning Agent shall determine which trade is responsible for executing and documenting each of the line-item tasks and note that trade on the form. Each form may have more than one trade responsible for its execution.
  4. The Contractor shall submit the startup reports to the CA for review.
- D. The CA shall review and approve the procedures and the format for documenting them, noting any procedures that need to be added.
- E. Two weeks prior to startup, the contractor shall schedule startup and checkout with the Owner and CA. The execution of the startup and checkout shall be directed and performed by the contractor, in accordance with manufacturer's published procedures and with the approved procedures. The CA shall be present for the contractor's required startup and checkout of all systems and equipment to be commissioned.
- F. Sensor Calibration. Calibration of all sensors shall be included as part of the prefunctional testing and listed on the appropriate test checklists and reports, according to the specified procedures and accuracy for the devices and systems being tested.
- G. All contractor responsible start-up, checkout forms shall be completed and submitted to the CA for review. The commissioning agent shall conduct an independent start-up and checkout plan following the prefunctional testing format.

### 3.3 FUNCTIONAL PERFORMANCE TESTS

- A. Functional Performance Verification (FPV) is the dynamic testing of systems (rather than just individual components) under full, part, and seasonal requirements. Systems are tested under various loads and control sequences, such as low cooling and heating loads, component failures, unoccupied modes, fire alarm, etc. The systems are run through all the control sequences of operation and components are verified to be

responding as the design intent and documents. Functional performance verification shall include testing all sequences of operations, verification of system capacity, generating simulated signals to simulate sensor values, conducting simulated conditions to tests all loads and verify system performance during all conditions of operation and verifying design intent. In addition, each system shall be tested through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part, and full load). Proper responses such as power failures, freeze conditions, low-oil pressures, equipment failures, etc. shall also be tested. The commissioning authority develops the functional test sheets and procedures in sequential written form, coordinates the testing, conducts the testing, and documents the testing. Each contractor is required is supply personnel to assist during the functional performance testing where applicable.

- B. No system, equipment or component thereof shall be tested until the contractor and the CM has certified, in writing, that the system, equipment and / or components are complete, have been tested, adjusted, and balanced and are ready for validating and performance testing. Functional Performance Verification is scheduled by the commissioning agent after the pre-functional testing requirements are complete and signed-off by the CM and the CA. Functional Performance Verification will not be conducted until a written notice of completion by the CM confirming that the system is ready for FPV. The air balancing and water balancing must be complete, and the controls must be debugged prior to the performance verification.
- C. Functional testing shall be conducted by the electrical contractor. Functional testing may not proceed until the systems have been professionally installed, started-up and all deficiencies have been corrected.
- D. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CA and CM. Beginning system testing before full completion shall not relieve the Contractor from fully completing the system, including all prefunctional checklists.
- E. The contractor shall provide personnel to operate the systems while functional performance testing is commencing. This shall include but not be limited to; starting and stopping of systems, opening, and closing valves to create false loads on the system and allowing the commissioning agent to manipulate the building automation systems to modulate the system requirements.
- F. The contractor shall review the commissioning functional performance testing procedure supplied by the commissioning agent. After functional testing commences, the contractor and the commissioning agent shall sign the functional test record and provide the owner and the CM a copy to review. All deficiencies either corrected in the field or outstanding shall be documented on the functional test forms for review by all parties.
- G. All Functional Testing must be completed and approved by the commissioning agent and the owner before the project will be considered substantially complete.

#### 3.4 DEFERRED TESTING

- A. **Deferred Testing.** The contractor shall be available to assist in seasonal testing, tests delayed until weather or other conditions building construction is completed, required building occupancy or loading, or other conditions are suitable for the demonstration of equipment or system's performance, as specified. These deferred tests shall be conducted in the same manner as the seasonal tests as soon as possible. Deferred testing shall be executed, documented and deficiencies corrected as specified herein for functional performance testing. Any adjustments or corrections to the O&M manuals and "As built" documents required by the results of the testing shall be made before the seasonal testing process is considered complete.

### 3.5 TESTING DOCUMENTATION, NON-CONFORMANCE, AND APPROVALS

- A. The commissioning agent shall clearly list any outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the testing form or on an attached sheet. The testing form and any outstanding deficiencies shall be provided to the OR / Owner within two days of test completion. The CA shall review the contractor's startup testing reports and shall submit either a non-compliance report or an approval form to the contractor. The CA shall work with the contractor and others as necessary, to correct and retest deficiencies or uncompleted items. The contractor shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner and shall notify the CA as soon as outstanding items have been corrected and resubmit an updated start-up report with a Statement of Correction on the original non-compliance report. When all requirements are satisfactorily completed, the CA shall recommend approval of the startup and prefunctional testing of each system and schedule the functional testing of the equipment or system.
- B. As functional performance testing progresses and a deficiency is identified, the CA shall discuss the issue with the executing contractor and the commissioning team.
  - 1. When there is no dispute of the deficiency and the contractor accepts responsibility for correcting it, the CA shall document the deficiency and the contractor's response and intentions and the testing shall proceed, if possible. Corrections of minor deficiencies identified may be made by the contractor during the functional performance testing, at the discretion of the CA. Every effort shall be made or expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the commissioning effort.
  - 2. When the identified deficiency is corrected, the contractor shall sign the statement of correction at the bottom of the non-compliance form, certifying that the equipment is ready to be retested, and return the form to the CA. The CA shall schedule the retest of the equipment or system involved.
  - 3. If there is a dispute about an identified deficiency, the CA shall document the deficiency and the contractor's response and provide a copy to the contractor. Every attempt shall be made to resolve the dispute at the lowest management level possible. When the dispute resolution has been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and returns the form to the CA. The CA shall schedule the retest of the equipment or system involved. Final interpretive authority shall be the A/E. Final acceptance authority shall be the Owner.
- C. During the functional performance testing of multiple units of similar equipment, the CA will test all the installed equipment and components identified. If, under such a testing procedure, three or more, identical pieces of equipment (size along does not constitute difference) fail to perform to the requirements of the Contract Documents (mechanically or substantively) due to manufacturing defects not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the CA. In such case, the contractor shall provide the CA with the following:
  - 1. Within one week of notification from the CA, the contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided to the CA within two weeks of the original notice.



2. Within two weeks of the original notification, the contractor shall provide the CA and the A/E a signed and dated, written explanation of the problem, cause of failures, etc. and proposed solution, including full equipment submittals for corrective or replacement equipment, if appropriate. The proposed solution shall not be for less than the specification requirements of the original installation.
3. When approved, two examples of the proposed solution shall be installed by the contractor and the CA shall schedule and conduct functional testing of the proposed solution. Upon completion of the functional testing of the proposed solution, the CA shall recommend the acceptance or disapproval of the proposed solution to the Owner.
4. Upon acceptance of the proposed solution by the Owner, the contractor shall replace or repair all identical items, at their expenses and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week of approval of the proposed solution.

D. Cost of Retesting

1. The cost for CA and/or Owner personnel to conduct the retesting of a functional performance testing requirements necessitated because a specific prefunctional or startup test item, reported to have been successfully completed, but found to be incomplete or faulty, shall be the responsibility of the contractor.
2. For a deficiency identified during the functional testing, not related to any prefunctional checklist or start-up fault, the CA and Owner shall direct the retesting of the equipment once at "no charge" for their time. However, all costs for any subsequent retesting shall be the responsibility of the contractor.
3. Items left incomplete, which later cause deficiencies or delays during functional testing may result in back charges to the responsible party.

### 3.6 OPERATIONS AND MAINTENANCE (O&M) MANUALS

- A. The following O&M manual requirements do not replace O&M manual documentation requirements elsewhere in these specifications.
- B. Division 26 shall compile and prepare documentation for all equipment and systems covered in Division 26 and deliver this documentation to the CM for inclusion in the O&M manuals, according to this section and Section 01730, prior to the training of owner personnel.
- C. The CA shall receive a copy of the O&M manuals for review.
- D. Operation and maintenance documentation, in hardback 3-ring loose-leaf binders except full size drawings and diskettes, shall cover all electrical systems. Documentation shall include the following: operations and maintenance documentation directory; emergency information; operating manual; emergency information; maintenance manual; test reports; and construction documents.
- E. The operation and maintenance documentation package shall be submitted as one comprehensive package to the Owner and CA before systems start-up and commissioning, and shall be updated, revised, and completed during, and at completion of, commissioning.

### 3.7 TRAINING OF OWNER PERSONNEL

- A. The electrical commissioning supervisor shall be responsible for training coordination and scheduling of required training and for ensuring that all required training is completed. The CA shall oversee the content and adequacy of the training of Owner personnel.
- B. Prepare and submit a syllabus describing an overview of the program, describing how the program will be conducted, when and where meetings are to be held, names and company affiliations of lecturers, description of contents and outline for each lecture, and recommended reference material and outside reading. Obtain direction from the Owner on which operating personnel shall be instructed in each system. Proposed training schedules, materials, and lesson plans shall be submitted to the CA for review of the content and adequacy of the training of Owner personnel for commissioned equipment or systems.
- C. Electrical Contractor – the electrical contractor shall have the following training responsibilities:
  - 1. Provide the CA with training plan one week before the planned training.
  - 2. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment.
  - 3. Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment.
  - 4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary, and the demonstration repeated.
  - 5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the startup technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.
  - 6. The controls contractor shall attend sessions other than the controls training, for each type of equipment that interacts with the BAS, to discuss the interaction of the BAS as it relates to the equipment being discussed.
  - 7. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.

### 3.8 WRITTEN WORK PRODUCTS

- A. Written work products of Contractors will consist of the startup and initial checkout plan and the filled-out startup, checkout and prefunctional and functional checklists.

END OF SECTION

SECTION 260923

LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 STIPULATIONS

- A. A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full

1.2 SUMMARY

A. Section Includes:

1. Electronic dial-time switches.
2. Electromechanical dial-time switches.
3. Outdoor photoelectric switches, solid state, flexible mounting.
4. Outdoor photoelectric switches, solid state, luminaire-mounted.
5. Outdoor photoelectric switches, low voltage.
6. Daylight-harvesting switching controls.
7. Daylight-harvesting dimming controls, digital.
8. Indoor occupancy and vacancy sensors.
9. Lighting contactors.
10. Emergency shunt relay.
11. Conductors and cables.

B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.
2. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Electronic dial-time switches.
2. Electromechanical dial-time switches.
3. Outdoor photoelectric switches, solid state, flexible mounting.
4. Outdoor photoelectric switches, solid state, luminaire-mounted.
5. Outdoor photoelectric switches, low voltage.
6. Daylight-harvesting switching controls.
7. Daylight-harvesting dimming controls, digital.
8. Indoor occupancy and vacancy sensors.
9. Lighting contactors.
10. Emergency shunt relay.
11. Conductors and cables.

B. Shop Drawings:

1. Show installation details for the following:
  - a. Occupancy sensors.
  - b. Vacancy sensors.
2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

C. Field quality-control reports.

#### 1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's warranties.

#### 1.5 WARRANTY

A. Special Extended Warranty: Manufacturer and Installer warrant that installed lighting control devices perform in accordance with specified requirements and agree to repair or replace, including labor, materials, and equipment, devices that fail to perform as specified within extended warranty period.

1. Failures include, but are not limited to, the following:
  - a. Faulty operation of lighting control software.
  - b. Faulty operation of lighting control devices.
2. Extended Warranty Period: Two year(s) from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 ELECTRONIC TIME SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton.
2. Intermatic, Inc.
3. Leviton Manufacturing Co., Inc.
4. Schneider Electric USA, Inc.

B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.

1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Contact Configuration: SPST.
3. Contact Rating: 30 A inductive or resistive, 240 V(ac).
4. Programs:
  - a. Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week and an annual holiday schedule that overrides the weekly operation on holidays.

5. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
6. Astronomic Time: All channels.
7. Automatic daylight savings time changeover.
8. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

## 2.2 ELECTROMECHANICAL DIAL-TIME SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Eaton.
  2. Intermatic, Inc.
  3. Leviton Manufacturing Co., Inc.
  4. Schneider Electric USA, Inc.
- B. Electromechanical-Dial Time Switches: Comply with UL 917.
  1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  2. Contact Configuration: SPST.
  3. Contact Rating: 30 A inductive or resistive, 240 V(ac).
  4. Circuitry: Allows connection of a photoelectric relay as a substitute for the on-off function of a program.
  5. Astronomic time dial.
  6. Eight-Day Program: Uniquely programmable for each weekday and holidays.
  7. Skip-a-day mode.
  8. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

## 2.3 OUTDOOR PHOTOELECTRIC SWITCHES, SOLID STATE, FLEXIBLE MOUNTING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Eaton.
  2. Intermatic, Inc.
  3. Leviton Manufacturing Co., Inc.
- B. Description: Solid state, with SPST dry contacts rated for 1800 VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A, and compatible with ballasts and LED lamps.
  1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range [, **and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off**].
  3. Time Delay: Fifteen-second minimum, to prevent false operation.
  4. Surge Protection: Metal-oxide varistor.
  5. Mounting: Twist lock complies with ANSI C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure from same source and manufacturer as switch.

6. Failure Mode : Luminaire stays ON.

#### 2.4 OUTDOOR PHOTOELECTRIC SWITCHES, SOLID STATE, LUMINAIRE-MOUNTED

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Eaton.
  2. Intermatic, Inc.
  3. Leviton Manufacturing Co., Inc.
- B. Description: Solid state, with SPST dry contacts rated for 1800 VA inductive, to operate connected load, complying with UL 773, and compatible with LED lamps.
  1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
  3. Time Delay: Thirty-second minimum, to prevent false operation.
  4. Lightning Arrester: Air-gap type.
  5. Mounting: Twist lock complying with ANSI C136.10, with base from same source and manufacturer as switch.
  6. Failure Mode : Luminaire stays ON.

#### 2.5 OUTDOOR PHOTOELECTRIC SWITCHES, LOW VOLTAGE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Eaton.
  2. Intermatic, Inc.
  3. Leviton Manufacturing Co., Inc.
- B. Description: Solid state; one set of NO dry contacts rated for 24 V(ac) at 1 A, to operate connected load, complying with UL 773, and compatible with luminaire and power pack.
  1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
  3. Time Delay: Thirty-second minimum, to prevent false operation.
  4. Mounting: 1/2 inch threaded male conduit.
  5. Failure Mode : Luminaire stays ON.
  6. Power Pack:
    - a. Dry contacts rated for 20 A LED load at 120 and 277 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.
      - 1) LED status lights to indicate load status.
      - 2) Plenum rated.
    - b. Digital controller capable of accepting four 8PSJ inputs with two outputs rated for 20 A LED load at 120 and 277 V(ac). Sensor has 24 V(dc), Class 2 power source.

- 1) With integral current monitoring.
- 2) Compatible with digital addressable lighting interface.
- 3) Plenum rated.

## 2.6 DAYLIGHT-HARVESTING SWITCHING CONTROLS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Lithonia Lighting; Acuity Brands Lighting, Inc.
  2. Sensor Switch, Inc.
  3. WattStopper; Legrand North America, LLC.
- B. Description: System operates indoor lighting.
- C. Sequence of Operation: As daylight increases, the lights are turned off at a predetermined level. As daylight decreases, the lights are turned on at a predetermined level.
1. Lighting control set point is based on two lighting conditions:
    - a. When no daylight is present.
    - b. When significant daylight is present (target level).
    - c. System programming is done with two hand-held, remote-control tools.
- D. Ceiling-Mounted Switching Controls:
1. Solid-state, light-level sensor unit, with power pack, that detects changes in indoor lighting levels that are perceived by the eye.
  2. Solid-state, light-level sensor unit, with separate power pack, that detects changes in indoor lighting levels that are perceived by the eye.
- E. Electrical Components, Devices, and Accessories:
1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
  3. Sensor Output:
    - a. Contacts rated to operate the associated power pack, complying with UL 773A. Sensor must be powered by the power pack.
    - b. Digital signal compatible with power pack.
  4. Sensor type: Open loop.
  5. Zone: Single.
  6. Power Pack:
    - a. Dry contacts rated for 20 A LED load at 120- and 277 V(ac).
      - 1) LED status lights to indicate load status.
      - 2) Plenum rated.
    - b. Digital controller capable of accepting four 8PSJ inputs with two outputs rated for 20 A LED load at 120 and 277 V(ac).

- 1) With integral current monitoring
  - 2) Compatible with digital addressable lighting interface.
  - 3) Plenum rated.
7. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc, with an adjustment for turn-on and turn-off levels within that range.
  8. Atrium Space Sensors Light-Level Monitoring Range: 100 to 1000 fc, with an adjustment for turn-on and turn-off levels within that range.
  9. Skylight Sensors Light-Level Monitoring Range: 1000 to 10 000 fc, with an adjustment for turn-on and turn-off levels within that range.
  10. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
  11. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
  12. Test Mode: User selectable, overriding programmed time delay to allow settings check.
  13. Control Load Status: User selectable to confirm that load wiring is correct.
  14. Indicator: Two digital displays to indicate the beginning of on-off cycles.

## 2.7 DAYLIGHT-HARVESTING DIMMING CONTROLS, DIGITAL

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Lithonia Lighting; Acuity Brands Lighting, Inc.
  2. WattStopper; Legrand North America, LLC.
- B. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, lights are dimmed.
  1. Lighting control set point is based on the following two lighting conditions:
    - a. When no daylight is present (target level).
    - b. When significant daylight is present.
  2. System programming is done with two hand-held, remote-control tools.
    - a. Initial setup tool.
    - b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.
- C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate power pack, to detect changes in indoor lighting levels that are perceived by the eye.
- D. Electrical Components, Devices, and Accessories:
  1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  2. Sensor Output: zero to 10 V(dc) to operate luminaires. Sensor is powered by controller unit.
  3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.
- E. Power Pack: Digital controller capable of accepting four 8PSJ inputs with two outputs rated for 20 A LED at 120 and 277 V(ac).
  1. With integral current monitoring.



2. Compatible with digital addressable lighting interface.
3. Plenum rated.

## 2.8 INDOOR OCCUPANCY AND VACANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Lithonia Lighting; Acuity Brands Lighting, Inc.
  2. Lutron Electronics Co., Inc.
  3. Sensor Switch, Inc.
  4. WattStopper; Legrand North America, LLC.
- B. General Requirements for Sensors:
1. Wall or Ceiling mounted as indicated on drawings, solid-state indoor occupancy and vacancy sensors.
  2. Passive infrared and Ultrasonic Dual technology.
  3. Separate power pack.
  4. Hardwired connection to switch.
  5. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  6. Operation:
    - a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 20 minutes.
    - b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 20 minutes.
    - c. Combination Sensor: Unless otherwise indicated, sensor must be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 20 minutes.
  7. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
  8. Power: Line voltage.
  9. Power Pack: Dry contacts rated for 20 A LED load at 120 and 277 V(ac).
  10. Mounting:
    - a. Sensor: Suitable for mounting in any position in a standard device box or outlet box.
    - b. Relay: Externally mounted through a 1/2 inch knockout in a standard electrical enclosure.
    - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
  11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
  12. Bypass Switch: Override the "on" function in case of sensor failure.
  13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.

- C. PIR Type: Wall or Ceiling mounted as indicated on drawings; detect occupants in coverage area by their heat and movement.
  - 1. Detector Sensitivity: Detect occurrences of 6 inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch.
  - 2. Detection Coverage (Room, Ceiling Mounted): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96 inch high ceiling.
  - 3. Detection Coverage (Corridor, Ceiling Mounted): Detect occupancy within 90 ft. when mounted on a 10 ft. high ceiling.
  - 4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 sq. ft. when mounted 48 inch above finished floor.
  
- D. Ultrasonic Type: Wall or Ceiling mounted as indicated on drawings; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.
  - 1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inch in either a horizontal or a vertical manner at an approximate speed of 12 inch/s.
  - 2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96 inch high ceiling.
  - 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96 inch high ceiling.
  - 4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96 inch high ceiling.
  - 5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 ft. when mounted on a 10 ft. high ceiling in a corridor not wider than 14 ft.
  - 6. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 sq. ft. when mounted 84 inch above finished floor.
  
- E. Dual-Technology Type: Wall or Ceiling mounted as indicated on drawings; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
  - 1. Sensitivity Adjustment: Separate for each sensing technology.
  - 2. Detector Sensitivity: Detect occurrences of 6 inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch, and detect a person of average size and weight moving not less than 12 inch in either a horizontal or a vertical manner at an approximate speed of 12 inch/s.
  - 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96 inch high ceiling.
  - 4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 sq. ft. when mounted 48 inch above finished floor.

## 2.9 LIGHTING CONTACTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ASCO Power Technologies.
  - 2. Eaton.
  - 3. Leviton Manufacturing Co., Inc.
  - 4. Square D; Schneider Electric USA.

- B. Description: Electrically operated and mechanically held, combination-type lighting contactors with fusible switch, complying with NEMA ICS 2 and UL 508.
  - 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less THD of normal load current).
  - 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
  - 3. Enclosure: Comply with NEMA 250.
  - 4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

#### 2.10 EMERGENCY SHUNT RELAY

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Lighting Control and Design.
  - 2. WattStopper; Legrand North America, LLC.
- B. Description: NC, electrically held relay, arranged for wiring in parallel with or automatic switching contacts; complying with UL 924.
  - 1. Coil Rating: 277 V.

#### 2.11 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION OF SENSORS

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's instructions.

### 3.3 INSTALLATION OF WIRING

- A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 3/4 inch.
- B. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's instructions.
- C. Size conductors in accordance with lighting control device manufacturer's instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.

### 3.4 IDENTIFICATION

- A. Identify components and power and control wiring in accordance with Section 260553 "Identification for Electrical Systems."
  - 1. Identify controlled circuits in lighting contactors.
  - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

### 3.5 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Nonconforming Work:
  - 1. Lighting control devices will be considered defective if they do not pass tests and inspections.
  - 2. Remove and replace defective units and retest.
- C. Prepare test and inspection reports.
- D. Manufacturer Services:
  - 1. Engage factory-authorized service representative to support field tests and inspections as required.

### 3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
  - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
  - 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
  - 3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

### 3.7 MAINTENANCE

- A. Software and Firmware Service Agreement:
  - 1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement include software support for two years.
  - 2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Verify upgrading software includes operating system and new or revised licenses for using software.
    - a. Upgrade Notice: No fewer than 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.
  - 3. Upgrade Reports: Prepare written report after each update, documenting upgrades installed.

END OF SECTION

## SECTION 260936

### MODULAR DIMMING CONTROLS

#### PART 1 - GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. Wall-box multiscene dimming controls.
2. Multipreset modular dimming controls.
3. Conductors and cables.

###### B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.

##### 1.2 DEFINITIONS

- A. Fade Rate: The time it takes each zone to arrive at the next scene, dependent on the degree of change in lighting level.
- B. Scene: The lighting effect created by adjusting several zones of lighting to the desired intensity.
- C. SCR: Silicon-controlled rectifier.
- D. Zone: A luminaire or group of luminaires controlled simultaneously as a single entity. Also known as a "channel."

##### 1.3 ACTION SUBMITTALS

###### A. Product Data:

1. Wall-box multiscene dimming controls.
2. Multipreset modular dimming controls.
3. Conductors and cables.

###### B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on Project. Indicate dimensions, weights, arrangement of components, and clearance and access requirements.

1. Include elevation views of front panels of control and indicating devices and control stations.
2. Include diagrams for power, signal, and control wiring.
3. Address Drawing: Reflected ceiling plan and floor plans, showing connected luminaires, address for each luminaire, and luminaire groups. Base plans on construction plans, using the same legend, symbols, and schedules.
4. Point List and Data Bus Load: Summary list of control devices, sensors, ballasts, and other loads. Include percentage of rated connected load and device addresses.

5. Wire Termination Diagrams and Schedules: Coordinate nomenclature and presentation with Drawings and block diagram. Differentiate between manufacturer-installed and field-installed wiring.
  - a. Show interconnecting signal and control wiring, and interface devices that show compatibility of inputs and outputs.
  - b. For control interfaces and adapters, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the protocol.
- C. Field quality-control reports.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.

### PART 2 - PRODUCTS

#### 2.1 MODULAR DIMMING CONTROLS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Leviton Manufacturing Co., Inc.
  2. Lutron Electronics Co., Inc.
  3. Philips; Signify North America; Signify Holding.

#### 2.2 SYSTEM DESCRIPTION

- A. Compatibility:
  1. Dimming control components must be compatible with luminaires and drivers.
  2. Dimming control devices must be compatible with lighting control system components specified in Section 260923 "Lighting Control Devices."
- B. Dimmers and Dimmer Modules: Comply with UL 508.
  1. Audible Noise and RFI Suppression: Solid-state dimmers must operate smoothly over their operating ranges without audible lamp or dimmer noise or RFI. Modules must include integral or external filters to suppress audible noise and RFI.
  2. Dimmer or Dimmer-Module Rating: Not less than 125 percent of connected load unless otherwise indicated.
- C. Capacities: Unit must be rated for required devices or zones as indicated on drawings.
- D. Surge Protection: Withstand supply power surges without impairment to performance.
  1. Panels: 6000 V, 3000 A, complying with IEEE C62.41.1 and IEEE C62.41.2.
  2. Other System Devices: 6000 V, 3000 A, complying with IEEE C62.41.1 and IEEE C62.41.2.
- E. Off Control Position: User-selected off position of any control point must disconnect the load from line supply.

- F. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

### 2.3 WALL-BOX MULTISCENE DIMMING CONTROLS

- A. Description: Factory-fabricated equipment providing manual dimming consisting of a wall-box-mounted master controller and indicated number of wall-box zone stations. Controls and dimmers must be integrated for mounting in multigang wall box under a single wall plate. Each zone must be adjustable to indicated number of scenes, which must reside in the memory of zone controller.
- B. Dimmers:
  - 1. Each zone must be configurable to control the following loads:
    - a. LED lamps.
  - 2. Regulate voltages to maintain a constant light level, with no visible flicker, when the source voltage varies plus or minus 2 percent of RMS voltage.
- C. Memory:
  - 1. Retain preset scenes and fade rates through momentary (up to 3 s) power interruptions.
  - 2. Retain preset scenes through power failures for at least seven days.
- D. Device Cover Plates: Style, material, and color must comply with Section 260533.16 "Boxes and Covers for Electrical Systems". Master-control cover plate must be one piece.
- E. Master controller must include the following:
  - 1. Cover-mounted switches, including master off, all bright, and selectors for each scene.
  - 2. Cover-mounted LED indicator lights, one associated with each scene switch, and one for the master off switch.
  - 3. Concealed switches and indicators for specified function.
  - 4. A raise/lower switch for each zone for temporary adjustments of the zone, without altering scene values stored in memory.
  - 5. Fade time indicated by digital display for current scene while fading.
  - 6. Cover-mounted infrared receiver.
- F. Infrared Transmitters: Wireless remote control for recalling four of the presets. Operate up to 50 ft. (15 m) within line of sight of the master controller.

### 2.4 MULTIPRESET MODULAR DIMMING CONTROLS

- A. Description: Factory-fabricated equipment providing manual dimming consisting of the following:
  - 1. Master controller.
  - 2. Dimmer panels and indicated number of zone stations.
  - 3. Controls and dimmers must be integrated for mounting in a multigang wall box under a single wall plate.
  - 4. Each zone must be adjustable to indicated number of scenes, which must reside in the memory of zone controller.
- B. Dimmers:



1. Each zone must be configurable to control the following loads:
    - a. LED lamps.
    - b. Non-dim, on-off switching only.
  2. Regulate voltages to maintain a constant light level, with no visible flicker, when the source voltage varies plus or minus 2 percent of RMS voltage.
- C. Memory: Retain preset scenes and fade settings through power failures by retaining physical settings of controls.
- D. Device Cover Plates: Style, material, and color must comply with Section 260533.13 "Boxes and Covers for Electrical Systems". Master-control cover plate must be one piece.
- E. Master controller must include the following:
1. Wall-box style, single cover plate supplied by manufacturer.
  2. Cover-mounted switches, including master off, all bright, and selectors for each scene.
  3. Cover-mounted LED indicator lights, one associated with each scene switch, and one for the master off switch.
  4. Concealed switches and indicators for specified function.
  5. A raise/lower switch for each zone for temporary adjustments of the zone, without altering scene values stored in memory.
  6. Fade time indicated by digital display for current scene while fading.
  7. Cover-mounted infrared receiver.
- F. Dimmer Panels: Modular, plug-in type, complying with UL 508.
1. Integrated Short-Circuit Rating: 14 kA at 277 V.
  2. Dimmers:
    - a. Dimming Circuit: Two SCR dimmers, in inverse parallel configuration.
    - b. Dimming Curve: Modified square law as specified in "The Lighting Handbook" from IES; control voltage is zero to 10 V(dc).
    - c. Dimming Range: Zero to 100 percent, full output voltage not less than 98 percent of line voltage.
    - d. Voltage Regulation: Dimmer must maintain a constant light level, with no visible flicker, when the source voltage varies plus or minus 2 percent of RMS voltage.
- G. Circuit Breakers: Complying with UL 489 and classified as switch duty.

## 2.5 CONDUCTORS AND CABLES

- A. Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Class 2 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF WIRING

- A. Wiring Method: Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables" and Section 260533.13 "Conduits for Electrical Systems."
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's instructions.
- C. Size conductors in accordance with lighting control device manufacturer's instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.

### 3.2 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Label each dimmer module with a unique designation.
- C. Label each scene control button with approved scene description.

### 3.3 FIELD QUALITY CONTROL

- A. Field tests must be witnessed by Engineer.
- B. Tests and Inspections:
  - 1. Continuity tests of circuits.
  - 2. Operational Test: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
    - a. Include testing of modular dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.
- C. Nonconforming Work:
  - 1. Dimming control components will be considered defective if they do not pass tests and inspections.
  - 2. Remove and replace defective units and retest.
- D. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
- E. Reports: Prepare written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.
- F. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

END OF SECTION 260936

## SECTION 262213

### LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

###### A. Section Includes:

- 1. Distribution, dry-type transformers with nominal primary and secondary rating of 600 V and less, with capacities up to 112.5 kVA.

###### B. Related Requirements:

- 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.

##### 1.3 ACTION SUBMITTALS

###### A. Product Data:

- 1. For each type of product.
  - a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
  - b. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

###### B. Shop Drawings:

- 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
- 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
- 3. Include diagrams for power, signal, and control wiring.

###### C. Field Quality-Control Submittals:

- 1. Field quality-control reports.

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:

1. Transformer temporary heating, working clearances, anchoring, torque values, and insulation-resistance testing.

B. Source quality-control reports.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Inspection: On receipt, inspect for and note shipping damage to packaging and transformer.

1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

B. Storage: Store in warm, dry, and temperature-stable location in original shipping packaging.

C. Temporary Heating: Apply temporary heat in accordance with manufacturer's published instructions within enclosure of ventilated-type units, throughout periods during which equipment is not energized and when transformer is not in space that is continuously under normal control of temperature and humidity.

D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D; Schneider Electric USA (Basis of Design)
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.

B. Each type of transformer from single source from single manufacturer.

#### 2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60 Hz service.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

C. Transformers Rated 15 kVA and Larger:

1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2. Marked as compliant with DOE 2016 efficiency levels by qualified electrical testing laboratory recognized by authorities having jurisdiction.

D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside transformer enclosure.

## 2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70 and list and label as complying with UL 1561.
- B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
  - 1. One leg per phase.
  - 2. Core volume must allow efficient transformer operation at 10 percent above nominal tap voltage.
  - 3. Grounded to enclosure.
- C. Coils: Continuous windings without splices except for taps.
  - 1. Coil Material: Copper.
  - 2. Internal Coil Connections: Brazed or pressure type.
  - 3. Terminal Connections: Bolted.
- D. Encapsulation: Transformers smaller than 30 kVA must have core and coils completely resin encapsulated.
- E. Enclosure: Ventilated.
  - 1. Core and coil must be encapsulated within resin compound using vacuum-pressure impregnation process to seal out moisture and air.
  - 2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
  - 3. Wiring Compartment: Sized for conduit entry and wiring installation.
  - 4. Environmental Protection:
    - a. Indoor: UL 50E, Type 2.
    - b. Outdoor: UL 50E, Type 3R.
  - 5. Finish Color: Gray weather-resistant enamel.
- F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- H. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with maximum of 115 deg C rise above 40 deg C ambient temperature.
- I. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with maximum of 150 deg C rise above 40 deg C ambient temperature.
- J. Grounding: Provide ground-bar kit or ground bar installed on inside of transformer enclosure.
- K. Electrostatic Shielding: Windings must have independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
  - 1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
  - 2. Include special terminal for grounding shield.
- L. Wall Brackets: Manufacturer's standard brackets.

- M. Low-Sound-Level Requirements: Maximum sound levels when factory tested in accordance with IEEE C57.12.91, as follows:
1. 9.01 to 30.00 kVA: 45 dB(A-weighted).
  2. 30.01 to 50.00 kVA: 45 dB(A-weighted) for K-factors of 1, 4, and 9; 48 dB(A-weighted) for K-factors of 13 and 20.
  3. 50.01 to 150.00 kVA: 50 dB(A-weighted) for K-factors of 1, 4, and 9; 53 dB(A-weighted) for K-factors of 13 and 20.
  4. 150.01 to 300.00 kVA: 55 dB(A-weighted) for K-factors of 1, 4, and 9; 58 dB(A-weighted) for K-factors of 13 and 20.
  5. 300.01 to 500.00 kVA: 60 dB(A-weighted) for K-factors of 1, 4, and 9; 63 dB(A-weighted) for K-factors of 13 and 20.
  6. 500.01 to 700.00 kVA: 62 dB(A-weighted) for K-factors of 1, 4, and 9; 65 dB(A-weighted) for K-factors of 13 and 20.
- N. All transformers, whether floor or wall mounted, or suspended from the building structure, shall be mounted on Isomode vibration isolator pads. Immediate connections to and from transformer shall be through flexible conduit to avoid transmission of vibration to the conduit system or to the building structure. Complete shop drawings and details of vibration isolation shall be submitted to the Engineer for approval.

## 2.4 IDENTIFICATION

- A. Nameplates:
1. Engraved, laminated-acrylic or melamine plastic signs for distribution transformers, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

## 2.5 SOURCE QUALITY CONTROL

- A. Testing Administrant: Engage qualified electrical testing agency to evaluate transformer.
- B. Nonconforming Work:
1. System equipment that does not pass tests and inspections will be considered defective.
- C. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for transformers.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's published instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5  $\Omega$  at location of transformer.

- E. Environment: Enclosures must be rated for environment in which they are located. Covers for UL 50E, Type 4X enclosures may not cause accessibility problems.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.
  - 1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
  - 2. Brace wall-mounted transformers as specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems." and Section 260548.16 "Seismic Controls for Electrical Systems."
- B. Install transformers level and plumb on concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- C. Construct concrete bases and anchor floor-mounted transformers in accordance with manufacturer's published instructions, seismic requirements applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
  - 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- D. Secure transformer to concrete base in accordance with manufacturer's published instructions.
- E. Secure covers to enclosure and tighten bolts to manufacturer-recommended torques to reduce noise generation.
- F. Remove shipping bolts, blocking, and wedges.

### 3.3 CONNECTIONS

- A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. Provide flexible connections at conduit and conductor terminations and supports to eliminate sound and vibration transmission to building structure.

### 3.4 FIELD QUALITY CONTROL

- A. Testing Preparation:
  - 1. <Insert requirements>.



B. Field tests and inspections must be witnessed by authorities having jurisdiction.

C. Tests and Inspections:

1. Small (Up to 167 kVA Single-Phase or 500 kVA Three-Phase) Dry-Type Transformer Field Tests:

a. Visual and Mechanical Inspection.

- 1) Inspect physical and mechanical condition.
- 2) Inspect anchorage, alignment, and grounding.
- 3) Verify that resilient mounts are free and that shipping brackets have been removed.
- 4) Verify that unit is clean.
- 5) Perform specific inspections and mechanical tests recommended by manufacturer.
- 6) Verify that as-left tap connections are as specified.
- 7) Verify presence of surge arresters and that their ratings are as specified.

b. Electrical Tests:

- 1) Measure resistance at windings, taps, and bolted connections.
- 2) Perform insulation-resistance tests winding-to-winding and windings-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: value of index may not be less than 1.0.
- 3) Perform turns-ratio tests at tap positions. Test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
- 4) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

2. Large (Larger Than 167 kVA Single Phase or 500 kVA Three Phase) Dry-Type Transformer Field Tests:

a. Visual and Mechanical Inspection:

- 1) Inspect physical and mechanical condition.
- 2) Inspect anchorage, alignment, and grounding.
- 3) Verify that resilient mounts are free and that shipping brackets have been removed.
- 4) Verify that unit is clean.
- 5) Perform specific inspections and mechanical tests recommended by manufacturer.
- 6) Verify that as-left tap connections are as specified.
- 7) Verify presence of surge arresters and that their ratings are as specified.

b. Electrical Tests:

- 1) Measure resistance at windings, taps, and bolted connections.
- 2) Perform insulation-resistance tests winding-to-winding and windings-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS,

Table 100.5. Calculate polarization index: value of index may not be less than 1.0.

- 3) Perform power-factor or dissipation-factor tests on windings.
- 4) Perform turns-ratio tests at tap positions. Test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
- 5) Perform excitation-current test on each phase.
- 6) Perform applied voltage test online- and load-side windings to ground. See IEEE C57.12.91, Sections 10.2 and 10.9.
- 7) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

D. Test Labeling: On completion of satisfactory testing of units, attach dated and signed "Satisfactory Test" label to tested components.

E. Nonconforming Work:

1. Transformer will be considered defective if it does not pass tests and inspections.
2. Remove and replace units that do not pass tests or inspections and retest as specified above.

F. Assemble and submit test and inspection reports.

G. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

### 3.5 ADJUSTING

A. Record transformer secondary voltage at unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare written report recording output voltages and tap settings.

### 3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

### 3.7 MAINTENANCE

A. Infrared Scanning: Two months after Substantial Completion, perform infrared scan of transformer connections.

1. Use infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform two follow-up infrared scans of transformers, one at four months and another at 11 months after Substantial Completion.
3. Prepare certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION

## SECTION 262413

### SWITCHBOARDS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

###### A. Section Includes:

1. Switchboards.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.

###### B. Related Requirements

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.
2. Section 260573.19 "Arc-Flash Hazard Analysis" for arc-flash analysis and arc-flash label requirements.

##### 1.3 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

- B. Coordinate sizes and locations of concrete bases with actual equipment provided.

##### 1.4 ACTION SUBMITTALS

###### A. Product Data:

1. Switchboards.
2. Overcurrent protective devices.
3. Surge protection devices.
4. Ground-fault protection devices.
5. Accessories.
6. Other components.
7. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

- B. Shop Drawings: For each switchboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
  - 2. Detail enclosure types for types other than UL 50E, Type 1.
  - 3. Detail bus configuration, current, and voltage ratings.
  - 4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
  - 5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
  - 6. Detail utility company's metering provisions with indication of approval by utility company.
  - 7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - 8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.
  - 9. Include diagram and details of proposed mimic bus.
  - 10. Include schematic and wiring diagrams for power, signal, and control wiring.
- C. Samples: Representative portion of mimic bus with specified material and finish, for color selection.
- D. Field Quality-Control Submittals:
  - 1. Field Quality-Control Reports:
    - a. Test procedures used.
    - b. Test results that comply with requirements.
    - c. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:
  - 1. Handling, storing, and providing temporary heat.
  - 2. Mounting accessories and anchoring devices.
  - 3. Testing and adjusting overcurrent protective devices.
- B. Sample warranties.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Warranty documentation.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- B. Handle and prepare switchboards for installation in accordance with NECA 400 and NEMA PB 2.1.

## 1.8 WARRANTY

- A. Special Installer Extended Warranty: Installer warrants that fabricated and installed switchboard perform in accordance with specified requirements and agrees to repair or replace components that fail to perform as specified within extended-warranty period.
  - 1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.

## PART 2 - PRODUCTS

### 2.1 SWITCHBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Square D; Schneider Electric USA. (Basis of Design)
  - 2. Eaton.
  - 3. Siemens Industry, Inc., Energy Management Division.
- B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
- E. Comply with NEMA PB 2.
- F. Comply with NFPA 70.
- G. Comply with UL 891.
- H. Front-Connected, Front-Accessible Switchboards:
  - 1. Main Devices: Fixed, individually mounted.
  - 2. Branch Devices: Panel mounted.
  - 3. Sections front and rear aligned.
- I. Nominal System Voltage: 480Y/277 V.
- J. Main-Bus Continuous: 3000 A.
- K. Indoor Enclosures: Steel, UL 50E, Type 1.
- L. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over rust-inhibiting primer on treated metal surface.
- M. Barriers: Between adjacent switchboard sections.

- N. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.
- O. Service Entrance Rating: Switchboards intended for use as service entrance equipment may contain from one to six service disconnecting means with overcurrent protection, neutral bus with disconnecting link, grounding electrode conductor terminal, and main bonding jumper.
- P. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- Q. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- R. Pull Box on Top of Switchboard as required:
  - 1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
  - 2. Removable covers may form top, front, and sides. Top covers at rear must be easily removable for drilling and cutting.
  - 3. Bottom must be insulating, fire-resistive material with separate holes for cable drops into switchboard.
  - 4. Cable supports must be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.
- S. Buses and Connections: Three phase, four wire unless otherwise indicated.
  - 1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from front of switchboard.
  - 2. Phase- and Neutral-Bus Material:
    - a. Hard-drawn copper of 98 percent conductivity, silver-plated.
  - 3. Copper feeder circuit-breaker line connections.
  - 4. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.
  - 5. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
  - 6. Disconnect Links:
    - a. Isolate neutral bus from incoming neutral conductors.
    - b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
  - 7. Neutral Buses: 100 percent of ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
  - 8. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
- T. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

## 2.2 SURGE PROTECTION DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Square D; Schneider Electric USA.
  2. Eaton.
  3. Siemens Industry, Inc., Energy Management Division.
- B. SPDs: Listed and labeled in accordance with UL 1449, Type 1.
- C. Features and Accessories:
1. Internal thermal protection that disconnects SPD before damaging internal suppressor components.
  2. Indicator light display for protection status.
  3. Form-C contacts rated at **[5 A and 250 V(ac)] [2 A and 24 V(ac)] <Insert values>**, one normally open and one normally closed, for remote monitoring of protection status. **[ Contacts must reverse on failure of surge diversion module or on opening of current-limiting device. Coordinate with building power monitoring and control system.]**
  4. Surge counter.
- D. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase may not be less than 200 kA. Peak surge current rating must be arithmetic sum of ratings of individual MOVs in each mode.
- E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits may not exceed the following:
1. Line to Neutral: 1200 V for 480Y/277 V.
  2. Line to Ground: 1200 V for 480Y/277 V.
  3. Line to Line: 2000 V for 480Y/277 V.
- F. SCCR: Equal or exceed 100 kA.
- G. Nominal Rating: 20 kA.

## 2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  3. Electronic trip circuit breakers with RMS sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
    - a. Instantaneous trip.
    - b. Long- and short-time pickup levels.
    - c. Long and short time adjustments.
    - d. Ground-fault pickup level, time delay, and  $I^2t$  response.



4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
  5. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30 mA trip).
  6. MCCB Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
    - c. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    - d. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
    - e. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
    - f. Shunt Trip: 120 V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
    - g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
    - h. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
    - i. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.
- B. Insulated-Case Circuit Breaker (ICCB): 80 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
1. Fixed circuit-breaker mounting.
  2. Two-step, stored-energy closing.
  3. Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
    - a. Instantaneous trip.
    - b. Time adjustments for long- and short-time pickup.
    - c. Ground-fault pickup level, time delay, and I squared t response.
  4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
  5. Remote trip indication and control.
  6. Communication Capability: Web enabled integral Ethernet communication module and embedded Web server with factory-configured Web pages (HTML file format). Provide functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
  7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.
  8. Control Voltage: 120 V(ac).
- C. Bolted-Pressure Contact Switch: Operating mechanism uses rotary-mechanical-bolting action to produce and maintain high clamping pressure on switch blade after it engages stationary contacts.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Square D; Schneider Electric USA.

- b. Eaton.
  - c. Siemens Industry, Inc., Energy Management Division.
2. Main-Contact Interrupting Capability: Minimum of 12 times switch current rating.
  3. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.
    - a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
  4. Auxiliary Switches: Factory installed, SPDT, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
  5. Service-Rated Switches: Labeled for use as service equipment.
  6. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.
    - a. Configuration: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    - b. Internal Memory: Integrates cumulative value of intermittent arcing ground-fault currents and uses effect to initiate tripping.
    - c. No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.
    - d. Test Control: Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).
  7. Open-Fuse Trip Device: Arranged to trip switch open if phase fuse opens.
- D. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
  - E. Fuses are specified in Section 262813 "Fuses."

## 2.4 INSTRUMENTATION

- A. Instrument Transformers: NEMA EI 21.1, and the following:
  1. Potential Transformers: NEMA EI 21.1; 120 V, 60 Hz, **[single] [tapped] [double]** secondary; disconnecting type with integral fuse mountings. Burden and accuracy must be consistent with connected metering and relay devices.
  2. Current Transformers: NEMA EI 21.1; 5 A, 60 Hz, secondary; **[wound] [bushing] [bar or window]** type; **[single] [double]** secondary winding and secondary shorting device. Burden and accuracy must be consistent with connected metering and relay devices.
  3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
  4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
  1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
    - a. Phase Currents, Each Phase: Plus or minus 0.5 percent.

- b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
    - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
    - d. Megawatts: Plus or minus 1 percent.
    - e. Megavars: Plus or minus 1 percent.
    - f. Power Factor: Plus or minus 1 percent.
    - g. Frequency: Plus or minus 0.1 percent.
    - h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
    - i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
    - j. Contact devices to operate remote impulse-totalizing demand meter.
  - 2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
- C. Voltmeters: Cover expanded-scale range of nominal voltage plus 10 percent.
- D. Instrument Switches: Rotary type with off position.
- 1. Voltmeter Switches: Permit reading of phase-to-phase voltages and, where neutral is indicated, phase-to-neutral voltages.
  - 2. Ammeter Switches: Permit reading of current in each phase and maintain current-transformer secondaries in closed-circuit condition at all times.
- E. Ammeters: 2-1/2 inch minimum size with 90- or 120-degree scale. Meter and transfer device with off position, located on overcurrent device door for indicated feeder circuits only.
- F. Watt-Hour Meters and Wattmeters:
- 1. Comply with ANSI C12.1.
  - 2. Three-phase induction type with two stators, each with current and potential coil, rated 5 A, 120 V, 60 Hz.
  - 3. Suitable for connection to three- and four-wire circuits.
  - 4. Potential indicating lamps.
  - 5. Adjustments for light and full load, phase balance, and power factor.
  - 6. Four-dial clock register.
  - 7. Integral demand indicator.
  - 8. Contact devices to operate remote impulse-totalizing demand meter.
  - 9. Ratchets to prevent reverse rotation.
  - 10. Removable meter with drawout test plug.
  - 11. Semiflush mounted case with matching cover.
  - 12. Appropriate multiplier tag.
- G. Impulse-Totalizing Demand Meter:
- 1. Comply with ANSI C12.1.
  - 2. Suitable for use with switchboard watt-hour meter, including two-circuit totalizing relay.
  - 3. Cyclometer.
  - 4. Four-dial, totalizing kilowatt-hour register.
  - 5. Positive chart drive mechanism.
  - 6. Capillary pen holding minimum of one month's ink supply.
  - 7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
  - 8. Capable of indicating and recording 15-minute integrated demand of totalized system.

## 2.5 CONTROL POWER

- A. Control Circuits:
  - 1. 120 V(ac), supplied through secondary disconnecting devices from control-power transformer.
- B. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to primary side of each control-power transformer at line side of associated main circuit breaker. 120 V secondaries connected through automatic transfer relays to ensure fail-safe automatic transfer scheme.
- C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- D. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

## 2.6 ACCESSORY COMPONENTS AND FEATURES

- A. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with requirements in Section 260548.16 "Seismic Controls for Electrical Systems" or manufacturer's instructions.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Receive, inspect, handle, and store switchboards in accordance with NECA 400 and NEMA PB 2.1.
  - 1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's published instructions.
  - 2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
  - 3. Protect from moisture, dust, dirt, and debris during storage and installation.
  - 4. Install temporary heating during storage in accordance with manufacturer's published instructions.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect performance of equipment.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

### 3.3 INSTALLATION

- A. Comply with manufacturer's published instructions.
- B. Reference Standards:
  - 1. Switchboards and Accessories: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NECA 400 and NEMA PB 2.1.
  - 2. Consult Architect for resolution of conflicting requirements.
- C. Special Techniques:
  - 1. Equipment Mounting: Install switchboards on concrete base, 4 inch nominal thickness. Comply with requirements for concrete base specified in Section 260529 "Hangers and Supports for Electrical Systems."
    - a. Install conduits entering underneath switchboard, entering under vertical section where conductors will terminate. Install with couplings flush with concrete base. Extend 2 inch above concrete base after switchboard is anchored in place.
    - b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch centers around full perimeter of concrete base.
    - c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
    - d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, published instructions, and directions furnished with items to be embedded.
    - e. Install anchor bolts to elevations required for proper attachment to switchboards.
    - f. Anchor switchboard to building structure at top of switchboard if required or recommended by manufacturer.
  - 2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.
  - 3. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
  - 4. Operating Instructions: Frame and mount printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
  - 5. Install filler plates in unused spaces of panel-mounted sections.
  - 6. Install overcurrent protective devices, surge protection devices, and instrumentation.
    - a. Set field-adjustable switches and circuit-breaker trip ranges.

### 3.4 CONNECTIONS

- A. Comply with requirements for terminating feeder bus specified in Section 262500 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.
- B. Comply with requirements for terminating cable trays specified in Section 260536 "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

- C. Bond conduits entering underneath switchboard to equipment ground bus with bonding conductor sized in accordance with NFPA 70.
- D. Support and secure conductors within switchboard in accordance with NFPA 70.
- E. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

### 3.5 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting, and overcurrent protective device and each meter and control device mounted in compartment doors with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Mimic Bus:
  - 1. Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram.
  - 2. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce concise visual presentation of principal switchboard components and connections.
  - 3. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.
- E. Service Equipment Label: Labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

### 3.6 FIELD QUALITY CONTROL

- A. Field tests and inspections must be witnessed by authorities having jurisdiction.
- B. Tests and Inspections:
  - 1. Acceptance Testing:
    - a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within switchboard and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
    - b. Test continuity of each circuit.
  - 2. Test ground-fault protection of equipment for service equipment in accordance with NFPA 70.
  - 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  5. Perform the following infrared scan tests and inspections, and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
    - c. Instruments and Equipment:
      - 1) Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Nonconforming Work:
1. Switchboard will be considered defective if it does not pass tests and inspections.
  2. Remove and replace defective units and retest.
- D. Collect, assemble, and submit test and inspection reports, including certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- E. Manufacturer Services:
1. Engage factory-authorized service representative to support field tests and inspections as required.
- 3.7 ADJUSTING
- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.
  - B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Studies."
- 3.8 PROTECTION
- A. Temporary Heating: Apply temporary heat, to maintain temperature in accordance with manufacturer's published instructions, until switchboard is ready to be energized and placed into service.

END OF SECTION

## SECTION 262416

### PANELBOARDS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

###### A. Section Includes:

1. Power panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Disconnecting and overcurrent protective devices.

###### B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.

##### 1.3 DEFINITIONS

A. GFEP: Ground-fault equipment protection.

B. MCCB: Molded-case circuit breaker.

C. VPR: Voltage protection rating.

##### 1.4 ACTION SUBMITTALS

###### A. Product Data:

1. Power panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Disconnecting and overcurrent protective devices.
4. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
5. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

###### B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.



5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series rating of installed devices.
7. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for SPD as installed in panelboard.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include wiring diagrams for power, signal, and control wiring.
10. Key interlock scheme drawing and sequence of operations.
11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include Internet link for electronic access to downloadable PDF of coordination curves.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

- A. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- B. Manufacturers' Published Instructions: Record copy of official installation instructions issued to Installer by manufacturer for the following:
  1. Recommended procedures for installing panelboards.
  2. Recommended torque settings for bolted connections on panelboards.
  3. Recommended temperature range for energizing panelboards.

1.6 CLOSEOUT SUBMITTALS

- A. Warranty documentation.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Handle and prepare panelboards for installation in accordance with NECA 407 and NEMA PB 1.

PART 2 - PRODUCTS

2.1 PANELBOARDS COMMON REQUIREMENTS

- A. Fabricate and test panelboards in accordance with IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing agency recognized by authorities having jurisdiction and marked for intended location and application.
- D. Comply with NEMA PB 1.

- E. Comply with NFPA 70.
- F. Enclosures: Flush or Surface-mounted, dead-front cabinets, as indicated on the panel schedules on drawings.
  - 1. Rated for environmental conditions at installed location.
    - a. Indoor Dry and Clean Locations: UL 50E, Type 1.
    - b. Outdoor Locations: UL 50E, Type 3R.
    - c. Kitchen/Wash-Down Areas: UL 50E, stainless steel.
    - d. Other Wet or Damp Indoor Locations: UL 50E, Type 4.
  - 2. Height: 7 ft maximum.
  - 3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims must cover live parts and may have no exposed hardware.
  - 4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims must cover live parts and may have no exposed hardware.
  - 5. Finishes:
    - a. Panels and Trim: galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    - b. Back Boxes: Same finish as panels and trim.
- G. Incoming Mains:
  - 1. Location: Convertible between top and bottom.
  - 2. Main Breaker: Main lug interiors up to 400 A must be field convertible to main breaker.
- H. Phase, Neutral, and Ground Buses:
  - 1. Material: Hard-drawn copper, 98 percent conductivity.
    - a. Plating must run entire length of bus.
    - b. Bus must be fully rated for entire length.
  - 2. Interiors must be factory assembled into unit. Replacing switching and protective devices may not disturb adjacent units or require removing main bus connectors.
  - 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
  - 4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure.
  - 5. Do not mount neutral bus in gutter.
- I. Conductor Connectors: Suitable for use with conductor material and sizes.
  - 1. Material: Hard-drawn copper, 98 percent conductivity.
  - 2. Terminations must allow use of 75 deg C rated conductors without derating.
  - 3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
  - 4. Main and Neutral Lugs: Mechanical type, with lug on neutral bar for each pole in panelboard.
  - 5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with lug on bar for each pole in panelboard.

6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
  7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
  8. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
  9. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- J. Future Devices: Panelboards or load centers must have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
1. Percentage of Future Space Capacity: 10 percent.
- K. Panelboard Short-Circuit Current Rating:
1. Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for 100 percent interrupting capacity.
    - a. Panelboards and overcurrent protective devices rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
    - b. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V must have short-circuit ratings as shown on Drawings, but not less than 14 000 A(rms) symmetrical.
- L. Surge Suppression: Factory installed as integral part of indicated panelboards, complying with UL 1449 SPD Type 2.

## 2.2 POWER PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Square D; Schneider Electric USA.
  2. Eaton.
  3. Siemens Industry, Inc., Energy Management Division.
- B. Listing Criteria: NEMA PB 1, distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
1. For doors more than 36 inch high, provide two latches, keyed alike.
- D. Mains: Circuit breaker or Lugs only as indicated on drawings.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.
- G. Branch Overcurrent Protective Devices: Fused switches.

## 2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Square D; Schneider Electric USA.
  - 2. Eaton.
  - 3. Siemens Industry, Inc., Energy Management Division.
- B. Listing Criteria: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker or lugs only.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Door-in-door construction with concealed hinges; secured with flush or multipoint latch with tumbler lock; keyed alike. Outer door must permit full access to panel interior. Inner door must permit access to breaker operating handles and labeling, but current carrying terminals and bus must remain concealed.

## 2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Square D; Schneider Electric USA.
  - 2. Eaton.
  - 3. Siemens Industry, Inc., Energy Management Division.
- B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
  - 1. Thermal-Magnetic Circuit Breakers:
    - a. Inverse time-current element for low-level overloads.
    - b. Instantaneous magnetic trip element for short circuits.
    - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  - 3. Electronic Trip Circuit Breakers:
    - a. RMS sensing.
    - b. Field-replaceable rating plug or electronic trip.
    - c. Digital display of settings, trip targets, and indicated metering displays.
    - d. Multi-button keypad to access programmable functions and monitored data.
    - e. Ten-event, trip-history log. Each trip event must be recorded with type, phase, and magnitude of fault that caused trip.
    - f. Integral test jack for connection to portable test set or laptop computer.
    - g. Field-Adjustable Settings:
      - 1) Instantaneous trip.
      - 2) Long- and short-time pickup levels.
      - 3) Long and short time adjustments.
      - 4) Ground-fault pickup level, time delay, and I squared T response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6 mA trip).
6. GFEP Circuit Breakers: Class B ground-fault protection (30 mA trip).
7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240 V, single-pole configuration.
8. Subfeed Circuit Breakers: Vertically mounted.
9. MCCB Features and Accessories:
  - a. Standard frame sizes, trip ratings, and number of poles.
  - b. Breaker handle indicates tripped status.
  - c. UL listed for reverse connection without restrictive line or load ratings.
  - d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
  - e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
  - f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
  - g. Shunt Trip: 120 V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
  - h. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
  - i. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
  - j. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
  - k. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 A must have interchangeable rating plugs or electronic adjustable trip units.
  - l. Auxiliary Contacts: Two, SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
  - m. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
  - n. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.
  - o. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
  - p. Multipole units enclosed in single housing with single handle.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards in accordance with NECA 407 and NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Comply with manufacturer's published instructions.

- B. Reference Standards:

1. Panelboards: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NECA 407 and NEMA PB 1.1.
2. Consult Architect for resolution of conflicting requirements.

- C. Special Techniques:

1. Equipment Mounting:

- a. Attach panelboard to vertical finished or structural surface behind panelboard.
- b. Mount surface-mounted panelboards to steel slotted supports 1-1/4 inch in depth. Orient steel slotted supports vertically.
- c. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

3. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

4. Mount top of trim not higher than 6.5 ft above finished floor unless otherwise indicated. No operating handles, pushbuttons, switches or other operating devices shall be mounted higher than 6'-0" above finished floor to the highest point of the operating device. Adjust mounting heights as required to suit field conditions.

5. Mount panelboard cabinet plumb and rigid without distortion of box.

6. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

7. Install overcurrent protective devices and controllers not already factory installed.

- a. Set field-adjustable, circuit-breaker trip ranges.
- b. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver in accordance with manufacturer's published instructions.

8. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

9. Install filler plates in unused spaces.

10. Stub four 1 inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in future. Stub four 1 inch empty conduits into raised floor space or below slab not on grade.

11. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

12. Mount spare fuse cabinet in accessible location.

- D. Interfaces with Other Work:

1. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other

types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

### 3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."
- B. Panelboard Nameplates: Label each panelboard with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C. Device Nameplates: Label each branch circuit device in power panelboards with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.
- E. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles must be located on interior of panelboard door.
- F. Breaker Labels: Faceplate must list current rating, UL and IEC certification standards, and AIC rating.
- G. Circuit Directory:
  - 1. Provide directory card inside panelboard door, mounted in metal frame with transparent protective cover.
    - a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.
  - 2. Provide computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
    - a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.
  - 3. Create directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

### 3.4 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- B. Field tests and inspections must be witnessed by authorities having jurisdiction.
- C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. Do not perform optional tests. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
  - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
  - b. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
  - c. Instruments and Equipment:
    - 1) Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Nonconforming Work:

1. Panelboards will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Collect, assemble, and submit test and inspection reports, including certified report that identifies panelboards included and that describes scanning results, with comparisons of two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

F. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections as required.

### 3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Studies."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.

1. Measure loads during period of normal facility operations.
2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
4. Tolerance: Maximum difference between phase loads, within panelboard, may not exceed 20 percent.



3.6 PROTECTION

- A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature in accordance with manufacturer's published instructions.

END OF SECTION

## SECTION 262716

### ELECTRICAL CABINETS AND ENCLOSURES

#### PART 1 - GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. Cabinets and cutout boxes.
2. Termination boxes.
3. Miscellaneous enclosures.

###### B. Products Installed, but Not Furnished, under This Section:

1. See Section 260553 "Identification for Electrical Systems" for equipment labels.

###### C. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.

##### 1.2 DEFINITIONS

- ###### A. RBB: Rack bonding busbar, located in equipment cabinets and racks.

##### 1.3 ACTION SUBMITTALS

###### A. Product Data:

1. Cabinets and cutout boxes.
2. Termination boxes.
3. Miscellaneous enclosures.

###### B. Shop Drawings:

1. Shop drawings for custom enclosures and cabinets.
2. Shop drawings for racks or frames.

##### 1.4 INFORMATIONAL SUBMITTALS

###### A. Manufacturers' Published Instructions:

1. Cabinets and cutout boxes.
2. Termination boxes.
3. Miscellaneous enclosures.
4. Rack or frame systems.
5. Enclosure-mounted relocatable power taps.

## PART 2 - PRODUCTS

### 2.1 CABINETS AND CUTOOUT BOXES

#### A. Performance Criteria:

##### 1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

##### 2. Listing Criteria:

- a. UL CCN CYIV.
- b. Non-Environmental Characteristics: UL 50.
- c. Environmental Characteristics: UL 50E.

#### B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

#### C. UL CYIV - Indoor Sheet Metal Cabinets:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Business.
  - b. Cooper B-line; brand of Eaton, Electrical Sector.
  - c. Crouse-Hinds; brand of Eaton, Electrical Sector.
  - d. Hoffman; brand of nVent Electrical plc.
  - e. Siemens Industry, Inc., Building Technologies Division.
  - f. Square D; Schneider Electric USA.
2. General Characteristics: Enclosure provided with frame, mat, or trim in which swinging door or doors are or can be hung.
3. Options:
  - a. Degree of Protection: Type 1.

#### D. UL CYIV - Indoor Sheet Metal Cutout Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Business.
  - b. Cooper B-line; brand of Eaton, Electrical Sector.
  - c. Crouse-Hinds; brand of Eaton, Electrical Sector.
  - d. Hoffman; brand of nVent Electrical plc.
  - e. Siemens Industry, Inc., Building Technologies Division.
  - f. Square D; Schneider Electric USA.

2. General Characteristics: Enclosure that has swinging doors or covers secured directly to and telescoping with walls of enclosure.
3. Options:
  - a. Degree of Protection: Type 1.

E. UL CYIV - Outdoor Sheet Metal Cabinets:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Business.
  - b. Cooper B-line; brand of Eaton, Electrical Sector.
  - c. Crouse-Hinds; brand of Eaton, Electrical Sector.
  - d. Hoffman; brand of nVent Electrical plc.
  - e. Siemens Industry, Inc., Building Technologies Division.
  - f. Square D; Schneider Electric USA.
2. General Characteristics: Enclosure provided with frame, mat, or trim in which swinging door or doors are or can be hung.
3. Options:
  - a. Degree of Protection: Type 3R.

F. UL CYIV - Outdoor Sheet Metal Cutout Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Business.
  - b. Cooper B-line; brand of Eaton, Electrical Sector.
  - c. Crouse-Hinds; brand of Eaton, Electrical Sector.
  - d. Hoffman; brand of nVent Electrical plc.
  - e. Siemens Industry, Inc., Building Technologies Division.
  - f. Square D; Schneider Electric USA.
2. General Characteristics: Enclosure that has swinging doors or covers secured directly to and telescoping with walls of enclosure.
3. Options:
  - a. Degree of Protection: Type 3R.

## 2.2 TERMINATION BOXES

- A. Description: Enclosure for termination base consisting of lengths of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors or both.
- B. Performance Criteria:
  1. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:
  - a. UL CCN XCKT; including UL 1773.
  - b. Non-Environmental Characteristics: UL 50.
  - c. Environmental Characteristics: UL 50E.

C. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

D. UL XCKT - Termination Boxes and Termination Bases for Installation on Line Side of Service Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Business.
  - b. Cooper B-line; brand of Eaton, Electrical Sector.
  - c. Hoffman; brand of nVent Electrical plc.
  - d. Square D; Schneider Electric USA.
2. Additional Characteristics: Listed and labeled for installation on line side of service equipment.
3. Options:
  - a. Indoor Degree of Protection: Type 1.
  - b. Outdoor Degree of Protection: Type 3R.

E. UL XCKT - Termination Boxes and Termination Bases for Installation on Load Side of Service Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ABB, Electrification Business.
  - b. Cooper B-line; brand of Eaton, Electrical Sector.
  - c. Hoffman; brand of nVent Electrical plc.
  - d. Square D; Schneider Electric USA.
2. Additional Characteristics: Listed and labeled for installation on load side of service equipment.
3. Options:
  - a. Indoor Degree of Protection: Type 1.
  - b. Outdoor Degree of Protection: Type 3R.

## 2.3 MISCELLANEOUS ENCLOSURES

A. Performance Criteria:

1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Listing Criteria:
  - a. UL CCN XCKT; including UL 1773.
  - b. Non-Environmental Characteristics: UL 50.
  - c. Environmental Characteristics: UL 50E.
- B. Source Quality Control:
  1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
  2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.
- C. UL XCKT - Indoor Sheet Metal Miscellaneous Enclosures:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ABB, Electrification Business.
    - b. Cooper B-line; brand of Eaton, Electrical Sector.
    - c. Hoffman; brand of nVent Electrical plc.
    - d. Square D; Schneider Electric USA.
  2. Options:
    - a. Degree of Protection: Type 1.
- D. UL XCKT - Outdoor Sheet Metal Miscellaneous Enclosures:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ABB, Electrification Business.
    - b. Cooper B-line; brand of Eaton, Electrical Sector.
    - c. Hoffman; brand of nVent Electrical plc.
    - d. Square D; Schneider Electric USA.
  2. Options:
    - a. Degree of Protection: Type 3R.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Shop Drawings: Prepare and submit the following:
  1. Shop Drawings for Custom Enclosures and Cabinets: Include plans, elevations, sections, and attachment details.
  2. Shop Drawings for Racks or Frames:
    - a. Include plans, elevations, sections, details, and attachments to other work.

- b. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- c. Include workspace requirements and access for cable connections.
- d. Grounding: Indicate location of RBB and its mounting detail showing standoff insulators and wall-mounting brackets.

### 3.2 SELECTION OF ELECTRICAL CABINETS AND ENCLOSURES

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of electrical cabinets and enclosures. Consult Architect for resolution of conflicting requirements.
- B. Degree of Protection:
  - 1. Outdoors:
    - a. Type 3R unless otherwise indicated.
  - 2. Indoors:
    - a. Type 1 unless otherwise indicated.
    - b. Locations Exposed to Prolonged Submersion: Type 6P.

### 3.3 INSTALLATION ELECTRICAL CABINETS AND ENCLOSURES

- A. Comply with manufacturer's published instructions.
- B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:
  - 1. Cabinets and Cutout Boxes: Article 312 of NFPA 70.
  - 2. Consult Architect for resolution of conflicting requirements.
- C. Special Installation Techniques:
  - 1. Mount cabinets and enclosures at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.
  - 2. Do not install cabinets, enclosures, or fittings in contact with concrete or earth.
  - 3. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
  - 4. Identification: Provide labels for cabinets, enclosures, racks and associated electrical equipment.
    - a. Identify field-installed conductors, interconnecting wiring, and components.
    - b. Provide warning signs.
    - c. Label each cabinet, enclosure, and rack with engraved metal or laminated-plastic nameplate.

### 3.4 CLEANING

- A. Remove construction dust and debris from cabinets, enclosures, and racks.

### 3.5 PROTECTION

- A. Protect coatings and finishes of cabinets, enclosures, and racks from damage and deterioration.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION



## SECTION 262719

### MULTI-OUTLET ASSEMBLIES

#### PART 1 - GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. Wall-mounted, surface metal raceway multi-outlet assemblies.
2. Wall-mounted, surface nonmetallic raceway multi-outlet assemblies.
3. Floor-mounted, recessed metal raceway multi-outlet assemblies.
4. Floor-mounted, enclosure multi-outlet assemblies.

###### B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.
2. Section 260533.13 "Conduits for Electrical Systems" and Section 260533.23 "Surface Raceways for Electrical Systems" for raceways.
3. Section 260533.16 "Boxes and Covers for Electrical Systems" for floor boxes and covers.
4. Section 262726 "Wiring Devices" for receptacles and switches.

##### 1.2 ACTION SUBMITTALS

###### A. Product Data:

1. Wall-mounted, surface metal raceway multi-outlet assemblies.
2. Wall-mounted, surface nonmetallic raceway multi-outlet assemblies.
3. Floor-mounted, recessed metal raceway multi-outlet assemblies.
4. Floor-mounted, enclosure multi-outlet assemblies.

#### PART 2 - PRODUCTS

##### 2.1 WALL-MOUNTED, SURFACE METAL RACEWAY MULTI-OUTLET ASSEMBLIES

A. Description: Two-piece surface metal raceway, field assembled and wired or with factory-wired multi-outlet harness, including outlets.

B. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

###### C. General Characteristics:

1. Reference Standards: UL 5 for exposed power raceway and fittings. Multi-outlet assemblies used for communications or data must also comply with UL 5C for exposed communications raceway and fittings, and UL 2024 for communications cable routing.
2. Provide separate paths for management of telecommunications and power cables.

D. Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways, receptacles, and switches.

- E. Wall-Mounted, Surface Metal Raceway Power Multi-Outlet Assembly:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - b. Wiremold; Legrand North America, LLC.
  2. Options:
    - a. Material: [Steel] [Aluminum], with manufacturer's standard finish.
    - b. Color: As selected by Architect.
    - c. Power Outlets: in accordance with Section 262726 "Wiring Devices."
    - d. Power Outlet Spacing: 12 inch (300 mm).
    - e. Wiring: Single circuit in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

- F. Wall-Mounted, Surface Metal Raceway Power and Communications Multi-Outlet Assembly:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - b. Wiremold; Legrand North America, LLC.
  2. Options:
    - a. Material: Steel, with manufacturer's standard finish.
    - b. Color: as selected by Architect.
    - c. Power Outlets: in accordance with Section 262726 "Wiring Devices."
    - d. Power Outlet Spacing: 12 inch (300 mm).
    - e. Power Wiring: Single circuit in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

## 2.2 WALL-MOUNTED, SURFACE NONMETALLIC RACEWAY MULTI-OUTLET ASSEMBLIES

- A. Description: Two-piece surface nonmetallic raceway, field assembled and wired or with factory-wired multi-outlet harness, including outlets.
- B. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
- C. General Characteristics:
1. Reference Standards: UL 5A for exposed power raceway and fittings, UL 5C for exposed communications raceway and fittings, and UL 2024 for communications cable routing.
  2. Provide separate paths for management of telecommunications and power cables.
- D. Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways, receptacles, and switches.
- E. Wall-Mounted, Surface Nonmetallic Raceway Power Multi-Outlet Assembly:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - b. Wiremold; Legrand North America, LLC.
2. Options:
  - a. Material: PVC.
  - b. Color: as selected by Architect.
  - c. Power Outlets: in accordance with Section 262726 "Wiring Devices."
  - d. Power Outlet Spacing: 6 inch (150 mm).
  - e. Wiring: Single circuit in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Wall-Mounted, Surface Nonmetallic Raceway Power and Communications Multi-Outlet Assembly:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - b. Wiremold; Legrand North America, LLC.
2. Options:
  - a. Material: PVC.
  - b. Color: as selected by Architect.
  - c. Power Outlets: in accordance with Section 262726 "Wiring Devices."
  - d. Power Outlet Spacing: 6 inch (150 mm).
  - e. Power Wiring: Single circuit in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

2.3 FLOOR-MOUNTED, RECESSED METAL RACEWAY MULTI-OUTLET ASSEMBLIES

- A. Description: Two-piece flush-mounted, in-floor, metal raceway, with factory-wired multi-outlet harness, for installation flush in floor or under floor finish.
- B. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
- C. General Characteristics:
  1. Reference Standards: UL 5 for exposed power raceway and fittings, UL 5C for exposed communications raceway and fittings, and UL 2024 for communications cable routing.
  2. Provide separate paths for management of telecommunications and power cables.
- D. Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways and receptacles.
- E. Floor-Mounted, Recessed Metal Raceway Power Multi-Outlet Assembly <Insert drawing designation>:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - b. Wiremold; Legrand North America, LLC.
2. Options:
  - a. Load-Bearing Capacity: 1000 lb (450 kg).
  - b. Material: Steel, with manufacturer's standard finish.
  - c. Color: as selected by Architect.
  - d. Power Outlets: in accordance with Section 262726 "Wiring Devices" in surface-mounted enclosure capable of mounting anywhere along length of recessed raceway.
  - e. Wiring: Single circuit in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Floor-Mounted, Recessed Metal Raceway Power and Communications Multi-Outlet Assembly:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - b. Wiremold; Legrand North America, LLC.
2. Options:
  - a. Load-Bearing Capacity: 1000 lb (450 kg).
  - b. Material: Steel, with manufacturer's standard finish.
  - c. Color: as selected by Architect.
  - d. Power Outlets: in accordance with Section 262726 "Wiring Devices" in surface-mounted enclosure capable of mounting anywhere along length of recessed raceway.
  - e. Power Wiring: Single circuit in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

## 2.4 FLOOR-MOUNTED ENCLOSURE MULTI-OUTLET ASSEMBLIES

- A. Description: Floor-mounted box with cover enclosing multiple power and communications outlets in a single assembly.
- B. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
- C. General Characteristics:
  1. Reference Standards: UL 514A for metallic boxes; UL 514C for nonmetallic boxes, including scrub-water exclusion requirements; and UL 514D for cover plates.
  2. Provide separate paths for management of telecommunications and power cables in accordance with NFPA 76.
  3. Compartments: Barrier separates power from voice and data communication cabling.

- D. Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways and receptacles.
- E. Floor-Mounted Enclosure Multi-Outlet Assembly:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - b. Wiremold; Legrand North America, LLC.
  - 2. Options:
    - a. Floor Box and Cover:
      - 1) Provide floor boxes classified for use in 2-hour-rated concrete floors. Boxes for floors in contact with earth must be protected with an epoxy paint.
      - 2) Floor boxes for concrete floors must provide a minimum of 4 inch (100 mm) of adjustment prior to concrete pour and a minimum of 1/2 inch (12.5 mm) after concrete is set.
      - 3) Provide quantity of gangs as indicated on drawings.
      - 4) Provide brass or aluminum flanges approved for use on carpet, tile, or wood floor applications. Flanges and cover plates must have a buffed appearance and a protective finish. Covers must match appearance of floor flanges and provide access to included devices.
      - 5) Covers must lay flat on floor surface when open. Provide for cable egress when cover is closed. Provide ADA-compliant covers.
      - 6) Provide flanges, mounting brackets, keystones, and accessories for mounting devices and connections indicated on Drawings.
    - b. Outlets:
      - 1) Power Outlets: in accordance with Section 262726 "Wiring Devices."
      - 2) Wiring: Single circuit in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
      - 3) Voice and Data Communication Outlets: as indicated on drawings.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Comply with NECA 1 for device mounting heights, except where requirements on Drawings or in this Section are stricter.
- B. Comply with NECA 101 for installation requirements for steel raceways, except where requirements on Drawings or in this Section are stricter.
- C. Comply with NECA 102 for installation requirements for aluminum raceways, except where requirements on Drawings or in this Section are stricter.
- D. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies.
- E. Provide terminations, adapters, boxes, and other fittings required for installation.
- F. Install surface raceway with a minimum 2 inch (50 mm) radius control at bend points.

- G. Secure metallic surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inch (1200 mm) and with no fewer than two supports per straight raceway section. Support surface raceway in accordance with manufacturer's instructions. Tape and glue are unacceptable support methods.
- H. Do not install aluminum raceways or fittings in contact with concrete.
- I. Secure nonmetallic surface raceway with screws or other anchor-type devices in each wiring channel at intervals not exceeding 18 inch (460 mm) and with no fewer than two supports per straight raceway section in each wiring channel. Support nonmetallic surface raceway in accordance with manufacturer's instructions. Tape and glue are unacceptable support methods.
- J. Do not install PVC raceways where ambient temperature exceeds 122 deg F (50 deg C). Conductors with insulation rated higher than 75 deg C installed in PVC raceways may not be operated at a temperature greater than 75 deg C.
- K. Comply with Section 260526 "Grounding and Bonding for Electrical Systems."
- L. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and support.
- M. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.23 "Surface Raceways for Electrical Systems" for installation of raceways.
- N. Comply with requirements in Section 260533.16 "Boxes and Covers for Electrical Systems" for additional requirements for floor boxes.
- O. Coordination with Other Work:
  - 1. Adjust locations of multi-outlet assemblies to suit arrangement of partitions and furnishings. Locate outlets to avoid blocking by supports, furnishings, and other architectural fixtures.
  - 2. Provide outlets with special requirements, such as GFCI, AFCI, or special environmental requirements, where required by Drawings or to meet codes.
  - 3. Adjust locations of poke-through assembly penetrations to coordinate with locations of structural members, concealed piping, and concealed conduit. Obtain written approval from Architect prior to drilling penetrations in floors other than where dimensioned on architectural Drawings. Comply with requirements in Section 078413 "Penetration Firestopping."

### 3.2 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."

END OF SECTION

## SECTION 262726

### WIRING DEVICES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

A. Section Includes:

1. General-use switches, dimmer switches, and fan-speed controller switches.
2. General-grade single straight-blade receptacles.
3. General-grade duplex straight-blade receptacles.
4. Hospital-grade straight-blade receptacles.
5. Receptacles with arc-fault and ground-fault protective devices.
6. Locking receptacles.
7. Pin-and-sleeve receptacles.
8. Special-purpose power outlet assemblies.
9. Connectors, cords, and plugs.

B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.
2. Section 260923 "Lighting Control Devices" for occupancy sensors, timers, control-voltage switches, and control-voltage dimmers.
3. Section 260936 "Modular Dimming Controls" for multiscene and multipreset dimming controls.
4. Section 262726.11 "General-Use Switches, Dimmer Switches, and Fan-Speed Controller Switches" for additional wiring device products.
5. Section 262726.31 "General-Grade Single Straight-Blade Receptacles" for additional wiring device products.
6. Section 262726.33 "General-Grade Duplex Straight-Blade Receptacles" for additional wiring device products.
7. Section 262726.35 "Hospital-Grade Straight-Blade Receptacles" for additional wiring device products.
8. Section 262726.37 "Receptacles with Ground-Fault Protective Devices" for additional wiring device products.
9. Section 262726.39 "Locking Receptacles" for additional wiring device products.

##### 1.3 DEFINITIONS

- A. UL 1472 Type I Dimmer: Dimmer in which air-gap switch is used to energize preset lighting levels.

#### 1.4 ACTION SUBMITTALS

##### A. Product Data:

1. Toggle switches.
2. Dimmer switches.
3. Fan-speed controllers.
4. Single straight-blade receptacles
5. Duplex straight-blade receptacles.
6. Duplex straight-blade receptacles with integral switching means.
7. Hospital-grade straight-blade receptacles.
8. Receptacles with GFCI device.
9. Locking receptacles.

##### B. Shop Drawings:

1. Wiring diagrams for duplex straight-blade receptacles with integral switching means.

##### C. Field Quality-Control Submittals:

1. Field quality-control reports.

#### 1.5 INFORMATIONAL SUBMITTALS

##### A. Manufacturers' Instructions: Record copy of official installation instructions issued to Installer by manufacturer for the following:

1. Dimmers.
2. Fan-speed controllers.
3. Single straight-blade receptacles.
4. Duplex straight-blade receptacles.
5. Duplex straight-blade receptacles with integral switching means.
6. Hospital-grade straight-blade receptacles.
7. Receptacles with GFCI device.
8. Locking receptacles.

### PART 2 - PRODUCTS

#### 2.1 GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES

##### A. Toggle Switch:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - c. Leviton Manufacturing Co., Inc.
  - d. Pass & Seymour; Legrand North America, LLC.
2. Regulatory Requirements:



- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
- 3. General Characteristics:
  - a. Reference Standards: UL CCN WMUZ and UL 20.
- 4. Options:
  - a. Device Color: As selected by Architect.
  - b. Configuration:
    - 1) Extra-heavy-duty, 120-277 V, 20 A, as indicated on drawings.
    - 2) Extra-heavy-duty, 120-277 V, 30 A, as indicated on drawings.
- B. Type I Dimmer Switch:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Lutron Electronics Co., Inc.
    - e. Pass & Seymour; Legrand North America, LLC.
  - 2. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  - 3. General Characteristics:
    - a. Reference Standards: UL CCN EOYX and UL 1472 Type I dimmer.
  - 4. Options:
    - a. Device Color: As selected by Architect.
    - b. Switch Style: Push button.
    - c. Dimming Control Style: Slide.
- C. Air-Gap Fan-Speed Controller Switch:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.

2. Regulatory Requirements:
  - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
3. General Characteristics:
  - a. Reference Standards: UL CCN GQHG and UL 1917.
4. Options:
  - a. Device Color: As selected by Architect.

## 2.2 GENERAL-GRADE SINGLE STRAIGHT-BLADE RECEPTACLES

### A. Single Straight-Blade Receptacle:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - c. Leviton Manufacturing Co., Inc.
  - d. Pass & Seymour; Legrand North America, LLC.
2. Regulatory Requirements:
  - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
3. General Characteristics:
  - a. Reference Standards: UL CCN RTRT and UL 498.
4. Options:
  - a. Device Color: As selected by Architect.
  - b. Configuration:
    - 1) Heavy-duty, as indicated on drawings.

### B. Tamper-Resistant, Clock Hanger Straight-Blade Receptacle:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - b. Pass & Seymour; Legrand North America, LLC.
2. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  - 3. General Characteristics:
    - a. Reference Standards: UL CCN RTRT and UL 498.
  - 4. Options:
    - a. Finish: Stainless steel.
    - b. Configuration: Recessed, smooth wallplate; NEMA 5-20R.
- C. Tamper-Resistant, Floor-Mounted Display Straight-Blade Receptacle:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - b. Pass & Seymour; Legrand North America, LLC.
  - 2. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  - 3. General Characteristics:
    - a. Reference Standards: UL CCN RTRT and UL 498.
    - b. Configuration: NEMA 5-20R.
  - 4. Options:
    - a. Finish: As selected by Architect.

## 2.3 GENERAL-GRADE DUPLEX STRAIGHT-BLADE RECEPTACLES

- A. Duplex Straight-Blade Receptacle:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  - 2. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

3. General Characteristics:
    - a. Reference Standards: UL CCN RTRT and UL 498.
  4. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration:
      - 1) Heavy-duty, NEMA 5-20R.
- B. Tamper-Resistant Duplex Straight-Blade Receptacle:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  2. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  3. General Characteristics:
    - a. Reference Standards: UL CCN RTRT and UL 498.
  4. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration:
      - 1) Heavy-duty, NEMA 5-20R.
- C. Tamper-Resistant Duplex Straight-Blade Receptacle with USB Outlet to Power Class 2 Equipment:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  2. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  - 3. General Characteristics:
    - a. Reference Standards: UL CCN RTRT and UL 498.
  - 4. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration:
      - 1) General-duty, NEMA 5-20R; one USB-A port; one USB-C port.
- D. Wired Full-Controlled Duplex Straight-Blade Receptacle:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - b. Pass & Seymour; Legrand North America, LLC.
  - 2. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  - 3. General Characteristics:
    - a. Reference Standards: UL CCN RTX1 and UL Subject 498B.
  - 4. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration: NEMA 5-20R.
- E. Wired Half-Controlled Duplex Straight-Blade Receptacle:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - b. Pass & Seymour; Legrand North America, LLC.
  - 2. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  - 3. General Characteristics:

- a. Reference Standards: UL CCN RTX1 and UL Subject 498B.
- 4. Options:
  - a. Device Color: As selected by Architect.
  - b. Configuration: NEMA 5-20R.

## 2.4 HOSPITAL-GRADE STRAIGHT-BLADE RECEPTACLES

### A. Hospital-Grade, Non-Ferrous Duplex Straight-Blade Receptacle:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - c. Leviton Manufacturing Co., Inc.
  - d. Pass & Seymour; Legrand North America, LLC.
- 2. Regulatory Requirements:
  - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
- 3. General Characteristics:
  - a. Reference Standards: UL CCN RTRT and UL 498.
- 4. Options:
  - a. Device Color: As selected by Architect.
  - b. Configuration: Extra-heavy-duty, NEMA 5-20R.

### B. Hospital-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - c. Leviton Manufacturing Co., Inc.
  - d. Pass & Seymour; Legrand North America, LLC.
- 2. Regulatory Requirements:
  - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
- 3. General Characteristics:
  - a. Reference Standards: UL CCN RTRT and UL 498.

4. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration:
      - 1) Heavy-duty, NEMA 5-20R.
- C. Hospital-Grade, Tamper-Resistant, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  2. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  3. General Characteristics:
    - a. Reference Standards: UL CCN RTRT and UL 498.
  4. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration:
      - 1) Heavy-duty, as indicated on drawings.
- D. Hospital-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with USB Outlet to Power Class 2 Equipment:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Pass & Seymour; Legrand North America, LLC.
  2. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  3. General Characteristics:
    - a. Reference Standards: UL CCN RTRT and UL 498.

4. Options:
  - a. Device Color: As selected by Architect.
  - b. Configuration:
    - 1) Heavy-duty, NEMA 5-20R; one USB-A port; one USB-C port.

## 2.5 RECEPTACLES WITH GROUND-FAULT PROTECTIVE DEVICES

### A. General-Grade, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - c. Leviton Manufacturing Co., Inc.
  - d. Pass & Seymour; Legrand North America, LLC.
2. Regulatory Requirements:
  - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
3. General Characteristics:
  - a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.
4. Options:
  - a. Device Color: As selected by Architect.
  - b. Configuration: Heavy-duty, NEMA 5-20R.

### B. General-Grade, Weather-Resistant, Tamper-Resistant, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle with GFCI Device:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - c. Leviton Manufacturing Co., Inc.
  - d. Pass & Seymour; Legrand North America, LLC.
2. Regulatory Requirements:
  - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
3. General Characteristics:



- a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.
- 4. Options:
  - a. Device Color: As selected by Architect.
  - b. Configuration: Heavy-duty, NEMA 5-20R.
- C. Hospital-Grade, Weather-Resistant, Tamper-Resistant, Nightlight-Type, Lighted Duplex Straight-Blade Receptacle with GFCI Device:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  - 2. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  - 3. General Characteristics:
    - a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.
  - 4. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration: Heavy-duty, NEMA 5-20R.

## 2.6 LOCKING RECEPTACLES

- A. NEMA, 125 V, Locking Receptacle:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  - 2. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  - 3. General Characteristics:

- a. Reference Standards: UL CCN RTRT and UL 498.
- 4. Options:
  - a. Device Color: Black with yellow voltage indication on face.
  - b. Configuration: 2 pole, 3 wire, grounding, as indicated on drawings.
- B. NEMA, 250 V, Locking Receptacle:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  - 2. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  - 3. General Characteristics:
    - a. Reference Standards: UL CCN RTRT and UL 498.
  - 4. Options:
    - a. Device Color: Black with blue voltage indication on face.
    - b. Configuration:
      - 1) 2 pole, 3 wire, grounding, as indicated on drawings.
      - 2) 3 pole, 4 wire, grounding, as indicated on drawings.
      - 3) 4 pole, 4 wire, non-grounding, as indicated on drawings.
      - 4) 4 pole, 5 wire, grounding, as indicated on drawings.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

##### A. Receptacles:

- 1. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

#### 3.2 SELECTION OF GFCI RECEPTACLES

- A. Healthcare Facilities: Unless protection of downstream branch-circuit wiring, cord sets, and power-supply cords is required by NFPA 70 or NFPA 99, provide non-feed-through GFCI receptacles.

### 3.3 INSTALLATION OF SWITCHES

- A. Comply with manufacturer's instructions.
- B. Reference Standards:
  - 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
  - 2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
  - 3. Consult Architect for resolution of conflicting requirements.
- C. Identification:
  - 1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
    - a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.
    - b. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

### 3.4 INSTALLATION OF STRAIGHT-BLADE RECEPTACLES

- A. Comply with manufacturer's instructions.
- B. Reference Standards:
  - 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
  - 2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
  - 3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
    - a. Hospital-Grade Receptacle Orientation: Orient receptacle with ground pin or neutral pin at top.
  - 4. Consult Architect for resolution of conflicting requirements.
- C. Identification:
  - 1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
    - a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.
    - b. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

### 3.5 INSTALLATION OF LOCKING RECEPTACLES

- A. Comply with manufacturer's instructions.
- B. Reference Standards:
  - 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
  - 2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
  - 3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
  - 4. Consult Architect for resolution of conflicting requirements.
- C. Identification:
  - 1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
    - a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.
    - b. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

### 3.6 FIELD QUALITY CONTROL OF SWITCHES

- A. Field tests and inspections must be witnessed by authorities having jurisdiction.
- B. Tests and Inspections:
  - 1. Perform tests and inspections in accordance with manufacturers' instructions.
- C. Nonconforming Work:
  - 1. Unit will be considered defective if it does not pass tests and inspections.
  - 2. Remove and replace defective units and retest.
- D. Assemble and submit test and inspection reports.

### 3.7 FIELD QUALITY CONTROL OF STRAIGHT-BLADE RECEPTACLES

- A. Field tests and inspections must be witnessed by authorities having jurisdiction.
- B. Tests and Inspections:
  - 1. Insert and remove test plug to verify that device is securely mounted.
  - 2. Verify polarity of hot and neutral pins.
  - 3. Measure line voltage.
  - 4. Measure percent voltage drop.
  - 5. Measure grounding circuit continuity: impedance must be not greater than 2 ohms.
  - 6. Healthcare Facilities: Test straight-blade receptacles in patient care spaces with receptacle pin tension test instrument in accordance with NFPA 99. Retention force of ground pin must be not less than 115 g (4 oz).

7. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.

C. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Assemble and submit test and inspection reports.

### 3.8 FIELD QUALITY CONTROL OF LOCKING RECEPTACLES

A. Field tests and inspections must be witnessed by authorities having jurisdiction.

B. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity: impedance must be not greater than 2 ohms.
6. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.

C. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Assemble and submit test and inspection reports.

### 3.9 SYSTEM STARTUP FOR SWITCHES

A. Perform startup service.

1. Complete installation and startup checks for momentary switches, dimmer switches, and fan-speed controller switches in accordance with manufacturer's instructions.

### 3.10 ADJUSTING

A. Occupancy Adjustments for Controlled Receptacles: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

B. Cord Reels and Fittings: Adjust spring mechanisms and moving parts of cord reels and fittings to function smoothly and lubricate as recommended in writing by manufacturer.

### 3.11 PROTECTION

A. Devices:

1. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.

2. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION

## SECTION 262726.11

### GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES

#### PART 1 - GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. General-use switches.
2. General-use dimmer switches.
3. General-use fan-speed controller switches.

###### B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.
2. Section 260923 "Lighting Control Devices" for occupancy sensors, timers, control-voltage switches, and control-voltage dimmers.
3. Section 260936 "Modular Dimming Controls" for multiscene and multipreset dimming controls.

##### 1.2 DEFINITIONS

- A. UL 1472 Type I Dimmer: Dimmer in which air-gap switch is used to energize preset lighting levels.
- B. UL 1472 Type II Dimmer: Dimmer with air-gap switch that opens and closes load circuit at minimum output voltage setting only.
- C. UL 1472 Type IIa Dimmer: Dimmer with air-gap switch that opens and closes load circuit at maximum output voltage setting only.
- D. UL 1472 Type III Dimmer: Dimmer incorporating solid-state components providing preestablished rectified output settings.
- E. UL 1472 Type IV Dimmer: Dimmer not covered by UL 1472 Types I through III.

##### 1.3 ACTION SUBMITTALS

###### A. Product Data:

1. Toggle switches.
2. Key lock switches.
3. Maintained-contact switches.
4. Momentary-contact switches.
5. Rocker switches.
6. Dimmer switches.
7. Fan-speed controllers.

###### B. Field Quality-Control Submittals:

1. Field quality-control reports.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturers' Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:
  1. Dimmers.
  2. Fan-speed controllers.

### PART 2 - PRODUCTS

#### 2.1 GENERAL-USE SWITCHES

- A. Description: Snap switches intended for mounting in device boxes.
- B. Performance Criteria:
  1. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  2. General Characteristics:
    - a. Reference Standards: UL CCN WMUZ and UL 20.
- C. Toggle Switch:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  2. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration:
      - 1) General-duty, 120-277 V, 20 A, single pole, three way, or four way.
  3. Accessories:
    - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
    - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.
- D. Toggle Switch with Pilot Light:



1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  2. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration:
      - 1) Illuminated when load off, 120-277 V, 20 A, single pole or three way.
  3. Accessories:
    - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
    - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.
- E. Maintained-Contact, Center-Off, Toggle Switch:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  2. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration:
      - 1) Single pole, double throw, 120-277 V, 20 A.
- F. Momentary-Contact, Center-Off, Toggle Switch:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  2. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration: Single pole, double throw, 120-277 V, 20 A.

G. Rocker Switch:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - c. Leviton Manufacturing Co., Inc.
  - d. Pass & Seymour; Legrand North America, LLC.
2. Options:
  - a. Device Color: As selected by Architect.
  - b. Configuration:
    - 1) 120-277 V, 20 A, single pole, three way, or four way.
3. Accessories:
  - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
  - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

H. Rocker Switch with Pilot Light:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - c. Leviton Manufacturing Co., Inc.
  - d. Pass & Seymour; Legrand North America, LLC.
2. Options:
  - a. Device Color: As selected by Architect.
  - b. Configuration:
    - 1) Illuminated when load on, 120-277 V, 20 A, single pole or three way.
    - 2) Illuminated when load off, 120-277 V, 20 A, single pole.
3. Accessories:
  - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
  - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

2.2 GENERAL-USE DIMMER SWITCHES

- A. Description: Line-voltage dimmers intended for mounting in flush device boxes or on outlet box covers (wall box).
- B. Performance Criteria:

1. Regulatory Requirements:
  - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. General Characteristics:
  - a. Reference Standards: UL CCN EOYX and UL 1472.

C. Type I Dimmer Switch:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. GE Lighting; General Electric Company.
  - c. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - d. Leviton Manufacturing Co., Inc.
  - e. Lutron Electronics Co., Inc.
  - f. Pass & Seymour; Legrand North America, LLC.
2. Additional Characteristics: UL 1472 Type I dimmer.
3. Options:
  - a. Device Color: As selected by.
  - b. Switch Style: Toggle.
  - c. Dimming Control Style: Slide.
4. Accessories:
  - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
  - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

D. Type II Dimmer Switch:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. GE Lighting; General Electric Company.
  - c. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - d. Leviton Manufacturing Co., Inc.
  - e. Lutron Electronics Co., Inc.
  - f. Pass & Seymour; Legrand North America, LLC.
2. Additional Characteristics:
  - a. UL 1472 Type II dimmer.
  - b. Switch Style: Air-gap switch at dimmer control end of travel at minimum output voltage.

3. Options:
  - a. Device Color: As selected by Architect.
  - b. Dimming Control Style: Slide.
4. Accessories:
  - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
  - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

E. Type IIa Dimmer Switch:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. GE Lighting; General Electric Company.
  - c. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - d. Leviton Manufacturing Co., Inc.
  - e. Lutron Electronics Co., Inc.
  - f. Pass & Seymour; Legrand North America, LLC.
2. Additional Characteristics:
  - a. UL 1472 Type IIa dimmer.
  - b. Switch Style: Air-gap switch at dimmer control end of travel at maximum output voltage.
3. Options:
  - a. Device Color: As selected by.
  - b. Dimming Control Style: Slide.
4. Accessories:
  - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
  - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

F. Type III Dimmer Switch:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. GE Lighting; General Electric Company.
  - c. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - d. Leviton Manufacturing Co., Inc.
  - e. Lutron Electronics Co., Inc.
  - f. Pass & Seymour; Legrand North America, LLC.
2. Additional Characteristics: UL 1472 Type III dimmer.

3. Options:
  - a. Device Color: As selected by Architect.
  - b. Switch Style: Push-button].
  - c. Dimming Control Style: Push-button.
  - d. Network connection to provide programmable presets, scenes, and time-clock.

4. Accessories:
  - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
  - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

### 2.3 GENERAL-USE FAN-SPEED CONTROLLER SWITCHES

- A. Description: Semiconductor, capacitive-type, and inductive-type fan-speed controllers for regulating speed of fan motor, including starting and stopping of fan motor, intended for mounting in flush device boxes or on outlet box covers (wall box).
- B. Performance Criteria:
  1. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  2. General Characteristics:
    - a. Reference Standards: UL CCN GQHG and UL 1917.
- C. Air-Gap Fan-Speed Controller Switch:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  2. Options:
    - a. Device Color: As selected by Architect.
  3. Accessories:
    - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
    - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.
- D. Solid-State Fan-Speed Controller Switch:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
2. Options:
  - a. Device Color: As selected by Architect.
3. Accessories:
  - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
  - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Comply with manufacturer's instructions.
- B. Reference Standards:
  1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
  2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
  3. Consult Architect for resolution of conflicting requirements.
- C. Identification:
  1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
    - a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.
    - b. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

#### 3.2 FIELD QUALITY CONTROL

- A. Field tests and inspections must be witnessed by Engineer.
- B. Tests and Inspections:
  1. Perform tests and inspections in accordance with manufacturers' instructions.
- C. Nonconforming Work:
  1. Unit will be considered defective if it does not pass tests and inspections.
  2. Remove and replace defective units and retest.

- D. Assemble and submit test and inspection reports.
- E. Manufacturer Services:
  - 1. Engage factory-authorized service representative to support field tests and inspections.

### 3.3 SYSTEM STARTUP

- A. Perform startup service.
  - 1. Complete installation and startup checks for momentary switches, dimmer switches, and fan-speed controller switches in accordance with manufacturer's instructions.

### 3.4 PROTECTION

- A. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
- B. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION

## SECTION 262726.31

### GENERAL-GRADE SINGLE STRAIGHT-BLADE RECEPTACLES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

###### A. Section Includes:

- 1. Single straight-blade receptacles for plugs and attachment plugs.

###### B. Related Requirements:

- 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.
- 2. Section 262726.33 "General-Grade Duplex Straight-Blade Receptacles" for duplex receptacles.
- 3. Section 262726.35 "Hospital-Grade Straight-Blade Receptacles" for hospital-grade receptacles.
- 4. Section 262726.37 "Receptacles with Ground-Fault Protective Devices" for GFCI receptacles.
- 5. Section 262726.39 "Locking Receptacles" for locking receptacles.

##### 1.3 ACTION SUBMITTALS

###### A. Product Data:

- 1. Single straight-blade receptacles.

###### B. Field Quality-Control Submittals:

- 1. Field quality-control reports.

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturers' Instructions: Record copy of official installation instructions issued to Installer by manufacturer for the following:

- 1. Single straight-blade receptacles.

#### PART 2 - PRODUCTS

##### 2.1 SINGLE STRAIGHT-BLADE RECEPTACLES FOR PLUGS AND ATTACHMENT PLUGS

- A. Description: General-grade, single straight-blade receptacles for use in wiring systems recognized by NFPA 70.



- B. Performance Criteria:
  - 1. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  - 2. General Characteristics:
    - a. Reference Standards: UL CCN RTRT and UL 498.
- C. Single Straight-Blade Receptacle:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  - 2. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration:
      - 1) Heavy-duty, as indicated on drawings.
- D. Tamper-Resistant Single Straight-Blade Receptacle:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  - 2. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration:
      - 1) General-duty, NEMA 5-20R.
  - 3. Accessories:
    - a. Cover Plate: 0.060 inch (1.5 mm) thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
    - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

- E. Weather-Resistant Single Straight-Blade Receptacle:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  2. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration: Heavy-duty, NEMA 5-20R.
- F. Tamper-Resistant, Clock Hanger Straight-Blade Receptacle:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - b. Pass & Seymour; Legrand North America, LLC.
  2. Options:
    - a. Finish: Stainless steel.
    - b. Configuration: Recessed, smooth wallplate; NEMA 5-20R.
- G. Tamper-Resistant, Floor-Mounted Display Straight-Blade Receptacle:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - b. Pass & Seymour; Legrand North America, LLC.
  2. Additional Characteristics:
    - a. Configuration: NEMA 5-15R.
  3. Options:
    - a. Finish: As selected by Architect.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

### 3.2 INSTALLATION

- A. Comply with manufacturer's instructions.
- B. Reference Standards:
  - 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
  - 2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
  - 3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
  - 4. Consult Architect for resolution of conflicting requirements.
- C. Identification:
  - 1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
    - a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.
    - b. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

### 3.3 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. Insert and remove test plug to verify that device is securely mounted.
  - 2. Verify polarity of hot and neutral pins.
  - 3. Measure line voltage.
  - 4. Measure percent voltage drop.
  - 5. Measure grounding circuit continuity: impedance must be not greater than 2 ohms.
  - 6. Healthcare Facilities: Test straight-blade receptacles in patient care spaces with receptacle pin tension test instrument in accordance with NFPA 99. Retention force of ground pin must be not less than 115 g (4 oz).
  - 7. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.
- B. Nonconforming Work:
  - 1. Device will be considered defective if it does not pass tests and inspections.
  - 2. Remove and replace defective units and retest.
- C. Assemble and submit test and inspection reports.

### 3.4 PROTECTION

- A. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.

- B. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION

## SECTION 262726.33

### GENERAL-GRADE DUPLEX STRAIGHT-BLADE RECEPTACLES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

###### A. Section Includes:

1. Duplex straight-blade receptacles.
2. Duplex straight-blade receptacles with integral switching means.

###### B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.
2. Section 262726.31 "General-Grade Single Straight-Blade Receptacles" for single receptacles.
3. Section 262726.35 "Hospital-Grade Straight-Blade Receptacles" for hospital-grade receptacles.
4. Section 262726.37 "Receptacles with Ground-Fault Protective Devices" for GFCI receptacles.
5. Section 262726.39 "Locking Receptacles" for twist-locking receptacles.

##### 1.3 ACTION SUBMITTALS

###### A. Product Data:

1. Duplex straight-blade receptacles.
2. Duplex straight-blade receptacles with integral switching means.

###### B. Shop Drawings:

1. Wiring diagrams for duplex straight-blade receptacles with integral switching means.

###### C. Field Quality-Control Submittals:

1. Field quality-control reports.

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturers' Instructions: Record copy of official installation instructions issued to Installer by manufacturer for the following:

1. Duplex straight-blade receptacles.
2. Duplex straight-blade receptacles with integral switching means.

## PART 2 - PRODUCTS

### 2.1 DUPLEX STRAIGHT-BLADE RECEPTACLES

- A. Description: General-grade duplex receptacles for use in wiring systems recognized by NFPA 70.
- B. Performance Criteria:
  - 1. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  - 2. General Characteristics:
    - a. Reference Standards:
      - 1) UL CCN RTRT and UL 498.
      - 2) Surge Protective Devices: UL 1449, Type 3.
- C. Duplex Straight-Blade Receptacle:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  - 2. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration:
      - 1) Heavy-duty, NEMA 5-20R.
- D. Tamper-Resistant Duplex Straight-Blade Receptacle:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  - 2. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration:

- 1) Heavy-duty, NEMA 5-20R.

E. Weather-Resistant Duplex Straight-Blade Receptacle:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - c. Leviton Manufacturing Co., Inc.
  - d. Pass & Seymour; Legrand North America, LLC.
2. Options:
  - a. Device Color: As selected by Architect.
  - b. Configuration:
    - 1) Heavy-duty, NEMA 5-20R.

F. Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - c. Leviton Manufacturing Co., Inc.
  - d. Pass & Seymour; Legrand North America, LLC.
2. Options:
  - a. Device Color: As selected by Architect.
  - b. Configuration:
    - 1) Heavy-duty, smooth face, NEMA 5-20R.

G. Tamper-Resistant Duplex Straight-Blade Receptacle with USB Outlet to Power Class 2 Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - c. Leviton Manufacturing Co., Inc.
  - d. Pass & Seymour; Legrand North America, LLC.
2. Options:
  - a. Device Color: As selected by Architect.
  - b. Configuration:

- 1) General-duty, NEMA 5-20R; one USB-A port; one USB-C port.

## 2.2 DUPLEX STRAIGHT-BLADE RECEPTACLES WITH INTEGRAL SWITCHING MEANS

- A. Description: Controlled receptacles with integral switching means, intended to be installed on a 20 A maximum branch circuit and for use in dry locations, in accordance with NFPA 70.
- B. Performance Criteria:
  1. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  2. General Characteristics:
    - a. Reference Standards: UL CCN RTX1 and UL Subject 498B.
- C. Wired Full-Controlled Duplex Straight-Blade Receptacle:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Hubbell Lighting; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Pass & Seymour; Legrand North America, LLC.
  2. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration: NEMA 5-20R.
- D. Wired Half-Controlled Duplex Straight-Blade Receptacle:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Hubbell Lighting; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Pass & Seymour; Legrand North America, LLC.
  2. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration: NEMA 5-20R.



## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

### 3.2 INSTALLATION

- A. Comply with manufacturer's instructions.
- B. Reference Standards:
  - 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
  - 2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
  - 3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
  - 4. Consult Architect for resolution of conflicting requirements.
- C. Identification:
  - 1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
    - a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.
    - b. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

### 3.3 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. Insert and remove test plug to verify that device is securely mounted.
  - 2. Verify polarity of hot and neutral pins.
  - 3. Measure line voltage.
  - 4. Measure percent voltage drop.
  - 5. Measure grounding circuit continuity: impedance must be not greater than 2 ohms.
  - 6. Healthcare Facilities: Test straight-blade receptacles in patient care spaces with receptacle pin tension test instrument in accordance with NFPA 99. Retention force of ground pin must be not less than 115 g (4 oz).
  - 7. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.
- B. Nonconforming Work:
  - 1. Device will be considered defective if it does not pass tests and inspections.
  - 2. Remove and replace defective units and retest.
- C. Assemble and submit test and inspection reports.

### 3.4 PROTECTION

- A. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
- B. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION

## SECTION 262726.35

### HOSPITAL-GRADE STRAIGHT-BLADE RECEPTACLES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

###### A. Section Includes:

- 1. Hospital-grade straight-blade receptacles.

###### B. Related Requirements:

- 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.
- 2. Section 262726.31 "General-Grade Single Straight-Blade Receptacles" for single receptacles.
- 3. Section 262726.33 "General-Grade Duplex Straight-Blade Receptacles" for duplex receptacles that are not hospital grade.
- 4. Section 262726.37 "Receptacles with Ground-Fault Protective Devices" for GFCI receptacles.
- 5. Section 262726.39 "Locking Receptacles" for twist-locking receptacles.
- 6. Section 262726.41 "Pin-and-Sleeve Receptacles" for pin-and-sleeve receptacles.

##### 1.3 ACTION SUBMITTALS

###### A. Product Data:

- 1. Hospital-grade straight-blade receptacles.

###### B. Field Quality-Control Submittals:

- 1. Field quality-control reports.

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturers' Instructions: Record copy of official installation instructions issued to Installer by manufacturer for the following:

- 1. Hospital-grade straight-blade receptacles.

- B. Sample warranties.

## PART 2 - PRODUCTS

### 2.1 HOSPITAL-GRADE STRAIGHT-BLADE RECEPTACLES

- A. Description: Hospital-grade duplex receptacles for use in wiring systems recognized by NFPA 70.
- B. Performance Criteria:
  - 1. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  - 2. General Characteristics:
    - a. Reference Standards:
      - 1) UL CCN RTRT and UL 498.
      - 2) Surge Protective Devices: UL 1449, Type 3.
- C. Hospital-Grade Single Straight-Blade Receptacle:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  - 2. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration:
      - 1) Extra-heavy-duty, NEMA 5-20R.
- D. Hospital-Grade Duplex Straight-Blade Receptacle:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  - 2. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration:

- 1) Heavy-duty, NEMA 5-20R.

E. Hospital-Grade, Non-Ferrous Duplex Straight-Blade Receptacle:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - c. Leviton Manufacturing Co., Inc.
  - d. Pass & Seymour; Legrand North America, LLC.
2. Options:
  - a. Device Color: As selected by Architect.
  - b. Configuration: Extra-heavy-duty, NEMA 5-20R.

F. Hospital-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - c. Leviton Manufacturing Co., Inc.
  - d. Pass & Seymour; Legrand North America, LLC.
2. Options:
  - a. Device Color: As selected by Architect.
  - b. Configuration:
    - 1) Heavy-duty, NEMA 5-20R.

G. Hospital-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with USB Outlet to Power Class 2 Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - c. Pass & Seymour; Legrand North America, LLC.
2. Options:
  - a. Device Color: As selected by Architect.
  - b. Configuration:
    - 1) Heavy-duty, NEMA 5-20R; one USB-A port; one USB-C port.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

### 3.2 INSTALLATION

- A. Comply with manufacturer's instructions.
- B. Reference Standards:
  - 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
  - 2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
  - 3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
    - a. Hospital-Grade Receptacle Orientation: Orient receptacle with ground pin or neutral pin at top.
  - 4. Consult Architect for resolution of conflicting requirements.
- C. Identification:
  - 1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
    - a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.
    - b. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

### 3.3 FIELD QUALITY CONTROL

- A. Tests and Inspections:
  - 1. Insert and remove test plug to verify that device is securely mounted.
  - 2. Verify polarity of hot and neutral pins.
  - 3. Measure line voltage.
  - 4. Measure percent voltage drop.
  - 5. Measure grounding circuit continuity: impedance must be not greater than 2 ohms.
  - 6. Healthcare Facilities: Test straight-blade receptacles in patient care spaces with receptacle pin tension test instrument in accordance with NFPA 99. Retention force of ground pin must be not less than 115 g (4 oz).
  - 7. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.
- B. Nonconforming Work:
  - 1. Device will be considered defective if it does not pass tests and inspections.

2. Remove and replace defective units and retest.

C. Assemble and submit test and inspection reports.

### 3.4 PROTECTION

A. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.

B. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION

## SECTION 262726.37

### RECEPTACLES WITH GROUND-FAULT PROTECTIVE DEVICES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

###### A. Section Includes:

- 1. Receptacles with GFCI devices.

###### B. Related Requirements:

- 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.
- 2. Section 262726.31 "General-Grade Single Straight-Blade Receptacles" for single receptacles.
- 3. Section 262726.33 "General-Grade Duplex Straight-Blade Receptacles" for duplex receptacles that are not hospital grade.
- 4. Section 262726.35 "Hospital-Grade Straight-Blade Receptacles" for hospital-grade receptacles.
- 5. Section 262726.39 "Locking Receptacles" for twist-locking receptacles.

##### 1.3 ACTION SUBMITTALS

###### A. Product Data:

- 1. Receptacles with GFCI devices.

###### B. Field Quality-Control Submittals:

- 1. Field quality-control reports.

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturers' Instructions: Record copy of official installation instructions issued to Installer by manufacturer for the following:

- 1. Receptacles with GFCI devices.

#### PART 2 - PRODUCTS

##### 2.1 RECEPTACLES WITH GFCI DEVICES



- A. Description: Receptacles containing GFCI device for use in accordance with NFPA 70.
- B. Performance Criteria:
  - 1. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  - 2. General Characteristics:
    - a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.
- C. General-Grade Duplex Straight-Blade Receptacle with GFCI Device:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  - 2. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration: Heavy-duty, NEMA 5-20R.
- D. General-Grade, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  - 2. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration: Heavy-duty, NEMA 5-20R.
- E. General-Grade, Weather-Resistant Duplex Straight-Blade Receptacle with GFCI Device:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.

- d. Pass & Seymour; Legrand North America, LLC.
  - 2. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration: Heavy-duty, NEMA 5-20R.
- F. General-Grade, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  - 2. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration: Heavy-duty, NEMA 5-20R.
- G. Hospital-Grade Duplex Straight-Blade Receptacle with GFCI Device:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  - 2. Options:
    - a. Device Color: As selected by Architect.
    - b. Configuration: Heavy-duty, NEMA 5-20R.
- H. Hospital-Grade, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  - 2. Options:
    - a. Device Color: As selected by Architect.

- b. Configuration: Heavy-duty, NEMA 5-20R.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

#### 3.2 SELECTION OF GFCI RECEPTACLES

- A. Healthcare Facilities: Unless protection of downstream branch-circuit wiring, cord sets, and power-supply cords is required by NFPA 70 or NFPA 99, provide non-feed-through GFCI receptacles.

#### 3.3 INSTALLATION

- A. Comply with manufacturer's instructions.

- B. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
  - a. Hospital-Grade Receptacle Orientation: Orient receptacle with ground pin or neutral pin at top.
4. Consult Architect for resolution of conflicting requirements.

- C. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
  - a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.
  - b. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

#### 3.4 FIELD QUALITY CONTROL

- A. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity: impedance must be not greater than 2 ohms.

6. Healthcare Facilities: Test straight-blade receptacles in patient care spaces with receptacle pin tension test instrument in accordance with NFPA 99. Retention force of ground pin must be not less than 115 g (4 oz).
7. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.

B. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

C. Assemble and submit test and inspection reports.

3.5 PROTECTION

- A. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
- B. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION

SECTION 262726.39

LOCKING RECEPTACLES

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

A. Section Includes:

- 1. Locking receptacles.

B. Related Requirements:

- 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.
- 2. Section 262726.31 "General-Grade Single Straight-Blade Receptacles" for single receptacles.
- 3. Section 262726.33 "General-Grade Duplex Straight-Blade Receptacles" for duplex receptacles that are not hospital grade.
- 4. Section 262726.35 "Hospital-Grade Straight-Blade Receptacles" for hospital-grade receptacles.
- 5. Section 262726.37 "Receptacles with Ground-Fault Protective Devices" for GFCI receptacles.

1.3 ACTION SUBMITTALS

A. Product Data:

- 1. Locking receptacles.

B. Field Quality-Control Submittals:

- 1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturers' Instructions: Record copy of official installation instructions issued to Installer by manufacturer for the following:

- 1. Locking receptacles.

## PART 2 - PRODUCTS

### 2.1 LOCKING RECEPTACLES

- A. Description: Receptacles that require two motions, insertion and rotation, to fully mate attachment plugs.
- B. Performance Criteria:
  - 1. Regulatory Requirements:
    - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
  - 2. General Characteristics:
    - a. Reference Standards: UL CCN RTRT and UL 498.
- C. NEMA, 125 V, Locking Receptacle:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  - 2. Options:
    - a. Device Color: Black with yellow voltage indication on face.
    - b. Configuration: 2 pole, 3 wire, grounding, as indicated on drawings.
- D. NEMA, 125/250 V, Locking Receptacle:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
    - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
    - c. Leviton Manufacturing Co., Inc.
    - d. Pass & Seymour; Legrand North America, LLC.
  - 2. Options:
    - a. Device Color: Black with orange voltage indication on face.
    - b. Configuration:
      - 1) 3 pole, 3 wire, non-grounding, as indicated on drawings.
      - 2) 3 pole, 4 wire, grounding, as indicated on drawings.
- E. NEMA, 250 V, Locking Receptacle:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
  - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
  - c. Leviton Manufacturing Co., Inc.
  - d. Pass & Seymour; Legrand North America, LLC.
  
2. Options:
  - a. Device Color: Black with blue voltage indication on face.
  - b. Configuration:
    - 1) 2 pole, 3 wire, grounding, as indicated on drawings.
    - 2) 3 pole, 4 wire, grounding, as indicated on drawings.
    - 3) 4 pole, 4 wire, non-grounding, as indicated on drawings.
    - 4) 4 pole, 5 wire, grounding, as indicated on drawings.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

#### 3.2 INSTALLATION

- A. Comply with manufacturer's instructions.
- B. Reference Standards:
  1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
  2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
  3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
  4. Consult Architect for resolution of conflicting requirements.
- C. Identification:
  1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
    - a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.
    - b. Healthcare Facilities: Distinctively identify covers or cover plates of device boxes and outlet boxes that are supplied from life safety and critical branch power supplies following facility's standard practice.

#### 3.3 FIELD QUALITY CONTROL

- A. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity: impedance must be not greater than 2 ohms.
6. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.

B. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

C. Assemble and submit test and inspection reports.

3.4 PROTECTION

- A. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
- B. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION



## SECTION 262813

### FUSES

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.

##### 1.2 SUMMARY

- A. Section Includes:

1. Cartridge fuses rated 600 V ac and less for use in the following:
  - a. Control circuits.
  - b. Enclosed controllers.
  - c. Enclosed switches.
2. Spare-fuse cabinets.

##### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
  1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
    - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
  2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
  3. Current-limitation curves for fuses with current-limiting characteristics.
  4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in electronic format suitable for use in coordination software and in PDF format.
  5. Coordination charts and tables and related data.
  6. Fuse sizes for elevator feeders and elevator disconnect switches.

##### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017700 "Closeout Procedures," and Section 017823 "Operation and Maintenance Data," include the following:
  1. Ambient temperature adjustment information.

2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in electronic format suitable for use in coordination software and in PDF format.
4. Coordination charts and tables and related data.

#### 1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

#### 1.6 FIELD CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Bussmann; Eaton, Electrical Sector.
  2. Littelfuse, Inc.
  3. Mersen USA.
- B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

#### 2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
  1. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
  2. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, fast acting.
  3. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
  4. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

## 2.3 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
  - 1. Size: Adequate for storage of spare fuses specified with 10 percent spare capacity minimum.
  - 2. Finish: Gray, baked enamel.
  - 3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
  - 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
  - 1. Motor Branch Circuits: Class RK1, time delay.
  - 2. Large Motor Branch (601-4000 A): Class L, time delay.
  - 3. Other Branch Circuits: Class J, time delay.
  - 4. Control Transformer Circuits: Class CC, time delay, control transformer duty.
  - 5. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

### 3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Owner.

### 3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

## SECTION 262816

### ENCLOSED SWITCHES AND CIRCUIT BREAKERS

#### PART 1 - GENERAL

##### 1.1 SUMMARY

###### A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Shunt trip switches.
4. Molded-case circuit breakers (MCCBs).
5. Molded-case switches.
6. Enclosures.

###### B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.

##### 1.2 DEFINITIONS

A. GFEP: Ground-fault circuit-interrupter for equipment protection.

B. GFLS: Ground-fault circuit-interrupter for life safety.

C. SPDT: Single pole, double throw.

##### 1.3 ACTION SUBMITTALS

###### A. Product Data:

1. For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
2. Enclosure types and details for types other than UL 50E, Type 1.
3. Current and voltage ratings.
4. Short-circuit current ratings (interrupting and withstand, as appropriate).
5. Include evidence of qualified electrical testing laboratory listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
7. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF and electronic format.

###### B. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include wiring diagrams for power, signal, and control wiring.

- C. Field Quality-Control Submittals:
  - 1. Field quality-control reports.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Sample warranties.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Warranty documentation.

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Spare Parts: Furnish to Owner spare parts, for repairing enclosed switches and circuit breakers, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:
  - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  - 2. Fuse Pullers: Two for each size and type.

### PART 2 - PRODUCTS

#### 2.1 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain products from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

#### 2.2 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton.
  - 2. Siemens Industry, Inc., Energy Management Division.
  - 3. Square D; Schneider Electric USA.
- B. Type HD, Heavy Duty:
  - 1. Single throw.
  - 2. Three pole.
  - 3. 240 or 600 V(ac).
  - 4. 1200 A and smaller.
  - 5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses.
  - 6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Service-Rated Switches: Labeled for use as service equipment.
6. Hookstick Handle: Allows use of hookstick to operate handle.
7. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 24 V(ac).
8. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton.
2. Siemens Industry, Inc., Energy Management Division.
3. Square D; Schneider Electric USA.

B. Type HD, Heavy Duty, Three Pole, Single Throw, 240 or 600 V(ac), 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Hookstick Handle: Allows use of hookstick to operate handle.
6. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 24 V(ac).
7. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.4 SHUNT TRIP SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bussmann; Eaton, Electrical Sector.
2. Littelfuse, Inc.
3. Mersen USA.

B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with Class J fuse block and 200 kA interrupting and short-circuit current rating.

- C. Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible Switch: 240 or 600 V(ac), 30, 60, or 100A; UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, with clips or bolt pads to accommodate indicated fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Type HD, Heavy-Duty, Three Pole, Single-Throw Nonfusible Switch: 240 or 600 V(ac), 30, 60, or 100A; UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- E. Control Circuit: 120 V(ac); obtained from integral control power transformer, with primary and secondary fuses, with control power source of enough capacity to operate shunt trip, pilot, indicating and control devices.
- F. Accessories:
  - 1. Oiltight key switch for key-to-test function.
  - 2. Oiltight red and green ON pilot light.
  - 3. Isolated neutral lug; 100 percent rating.
  - 4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
  - 5. Three-pole, double-throw, fire-safety and alarm relay; 120 V(ac) coil voltage.
  - 6. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.
  - 7. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - 8. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
  - 9. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
  - 10. Service-Rated Switches: Labeled for use as service equipment.
  - 11. Hookstick Handle: Allows use of hookstick to operate handle.
  - 12. Form C alarm contacts that change state when switch is tripped.
  - 13. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 24 V(ac).
  - 14. Lugs: Mechanical type, suitable for number, size, and conductor material.

## 2.5 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton.
  - 2. Siemens Industry, Inc., Energy Management Division.
  - 3. Square D; Schneider Electric USA.
- B. Circuit breakers must be constructed using glass-reinforced insulating material. Current carrying components must be completely isolated from handle and accessory mounting area.
- C. Circuit breakers must have toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. Circuit-breaker handle must be over center, be trip free, and reside in tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon must be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with push-to-trip button, located on face of circuit breaker to mechanically operate circuit-breaker tripping mechanism for maintenance and testing purposes.

- D. Maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings must be clearly marked on face of circuit breaker. Circuit breakers must be 100 percent rated. Circuit breaker/circuit breaker combinations for series connected interrupting ratings must be listed by UL as recognized component combinations. Series rated combination used must be marked on end-use equipment along with statement "Caution - Series Rated System. Identical Replacement Component Required."
- E. MCCBs must be equipped with device for locking in isolated position.
- F. Lugs must be suitable for 60 deg C rated wire on 125 A circuit breakers and below.
- G. Standard: Comply with UL 489 with required interrupting capacity for available fault currents.
- H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, RMS sensing, with the following field-adjustable settings:
  - 1. Instantaneous trip.
  - 2. Long- and short-time pickup levels.
  - 3. Long- and short-time time adjustments.
  - 4. Ground-fault pickup level, time delay, and I-squared t response.
- K. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- L. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- M. GFLS Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6 mA trip).
- N. GFEP Circuit Breakers: With Class B ground-fault protection (30 mA trip).
- O. Features and Accessories:
  - 1. Standard frame sizes, trip ratings, and number of poles.
  - 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
  - 3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
  - 4. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.
  - 5. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
  - 6. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
  - 7. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay



- settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
8. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system, specified in Section 260913 "Electrical Power Monitoring and Control."
  9. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
  10. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.
  11. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
  12. Electrical Operator: Provide remote control for on, off, and reset operations.
  13. Accessory Control Power: Integrally mounted, self-powered; 24 V(ac).

## 2.6 MOLDED-CASE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Eaton.
  2. Siemens Industry, Inc., Energy Management Division.
  3. Square D; Schneider Electric USA.
- B. Description: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.
- D. Features and Accessories:
  1. Standard frame sizes and number of poles.
  2. Lugs:
    - a. Mechanical type, suitable for number, size, trip ratings, and conductor material.
    - b. Lugs must be suitable for 60 deg C rated wire on 125 A circuit breakers and below.
  3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
  4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
  5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
  6. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.
  7. Alarm Switch: One NO contact that operates only when switch has tripped.
  8. Key Interlock Kit: Externally mounted to prohibit switch operation; key must be removable only when switch is in off position.
  9. Zone-Selective Interlocking: Integral with ground-fault shunt trip unit; for interlocking ground-fault protection function.
  10. Electrical Operator: Provide remote control for on, off, and reset operations.
  11. Accessory Control Power Voltage: Integrally mounted, self-powered; 24 V(ac).

## 2.7 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, UL 50E, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: Enclosure must be finished with [gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (UL 50E Type 1) or gray baked enamel paint, electrodeposited on cleaned, phosphatized galvanized steel (UL 50E Types 3R, .
- C. Conduit Entry: UL 50E Types 4, 4X, and 12 enclosures may not contain knockouts. UL 50E Types 7 and 9 enclosures must be provided with threaded conduit openings in both endwalls.
- D. Operating Mechanism: Circuit-breaker operating handle must be [externally operable with operating mechanism being integral part of box, not cover; directly operable through dead front trim of enclosure (UL 50E Type 3R). Cover interlock mechanism must have externally operated override. Override may not permanently disable interlock mechanism, which must return to locked position once override is released. Tool used to override cover interlock mechanism must not be required to enter enclosure in order to override interlock.
- E. Enclosures designated as UL 50E Type 4, 4X stainless steel, 12, or 12K must have dual cover interlock mechanism to prevent unintentional opening of enclosure cover when circuit breaker is ON and to prevent turning circuit breaker ON when enclosure cover is open.
- F. UL 50E Type 7/9 enclosures must be furnished with breather and drain kit to allow their use in outdoor and wet location applications.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
  - 1. Commencement of work will indicate Installer's acceptance of areas and conditions as satisfactory.

### 3.2 SELECTION OF ENCLOSURES

- A. Indoor, Dry and Clean Locations: UL 50E, Type 1.
- B. Outdoor Locations: UL 50E, Type 3R.
- C. Kitchen and Wash-Down Areas: UL 50E, Type 4X, stainless steel.
- D. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: UL 50E, Type 12.

### 3.3 INSTALLATION

- A. Comply with manufacturer's published instructions.
- B. Special Techniques:

1. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
2. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
3. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
4. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
5. Install fuses in fusible devices.

### 3.4 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
  1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  2. Label each enclosure with engraved metal or laminated-plastic nameplate.

### 3.5 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
- B. Field tests and inspections must be witnessed by authorities having jurisdiction.
- C. Tests and Inspections for Switches:
  1. Visual and Mechanical Inspection:
    - a. Inspect physical and mechanical condition.
    - b. Inspect anchorage, alignment, grounding, and clearances.
    - c. Verify that unit is clean.
    - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
    - e. Verify that fuse sizes and types match the Specifications and Drawings.
    - f. Verify that each fuse has adequate mechanical support and contact integrity.
    - g. Inspect bolted electrical connections for high resistance using one of the following methods:
      - 1) Use low-resistance ohmmeter.
        - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
      - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
        - a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.
    - h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on Drawings.
    - i. Verify correct phase barrier installation.

- j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
2. Electrical Tests:
- a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
  - b. Measure contact resistance across each switchblade fuseholder. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
  - c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
  - d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
  - e. Perform ground fault test in accordance with NETA ATS Section 7.14 "Ground Fault Protection Systems, Low-Voltage."
- D. Tests and Inspections for Molded-Case Circuit Breakers:
1. Visual and Mechanical Inspection:
- a. Verify that equipment nameplate data are as described in the Specifications and shown on Drawings.
  - b. Inspect physical and mechanical condition.
  - c. Inspect anchorage, alignment, grounding, and clearances.
  - d. Verify that unit is clean.
  - e. Operate circuit breaker to ensure smooth operation.
  - f. Inspect bolted electrical connections for high resistance using one of the following methods:
    - 1) Use low-resistance ohmmeter.
      - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
    - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
      - a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.
  - g. Inspect operating mechanism, contacts, and chutes in unsealed units.
  - h. Perform adjustments for final protective device settings in accordance with coordination study.
2. Electrical Tests:

- a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
  - b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
  - c. Perform contact/pole resistance test. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
  - d. Perform insulation resistance tests on control wiring with respect to ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable. Test duration must be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values may be no less than 2 M  $\Omega$ .
  - e. Determine the following by primary current injection:
    - 1) Long-time pickup and delay. Pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
    - 2) Short-time pickup and delay. Short-time pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
    - 3) Ground-fault pickup and time delay. Ground-fault pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
    - 4) Instantaneous pickup. Instantaneous pickup values must be as specified and within manufacturer's published tolerances.
  - f. Test functionality of trip unit by means of primary current injection. Pickup values and trip characteristics must be as specified and within manufacturer's published tolerances.
  - g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of shunt trip and close coils must be as indicated by manufacturer.
  - h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset trip logs and indicators. Investigate units that do not function as designed.
  - i. Verify operation of charging mechanism. Investigate units that do not function as designed.
3. Test and adjust controls, remote monitoring, and safeties.
- E. Nonconforming Work:
1. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
  2. Remove and replace defective units and retest.
- F. Collect, assemble, and submit test and inspection reports.

1. Test procedures used.
2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
3. List deficiencies detected, remedial action taken, and observations after remedial action.

G. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

3.6 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Studies."

3.7 PROTECTION

- A. After installation, protect enclosed switches and circuit breakers from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.8 MAINTENANCE

- A. Infrared Scanning of Enclosed Switches and Breakers: Two months after Substantial Completion, perform infrared scan of joints and connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.
  1. Instruments and Equipment: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  2. Follow-up Infrared Scanning: Perform two follow-up infrared scans of enclosed switches and breakers, one at four months and another at 11 months after Substantial Completion.
  3. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
  4. Report: Prepare certified report that identifies units checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION

## SECTION 262913.03

### MANUAL AND MAGNETIC MOTOR CONTROLLERS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Manual motor controllers.
  - 2. Enclosed full-voltage magnetic motor controllers.
  - 3. Combination full-voltage magnetic motor controllers.
  - 4. Enclosures.
  - 5. Accessories.
  - 6. Identification.

##### 1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. NC: Normally closed.
- E. OCPD: Overcurrent protective device.
- F. SCCR: Short-circuit current rating.
- G. SCPD: Short-circuit protective device.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For each type of magnetic controller.
  - 1. Include plans, elevations, sections, and mounting details.
  - 2. Indicate dimensions, weights, required clearances, and location and size of each field connection.
  - 3. Wire Termination Diagrams and Schedules: Include diagrams for signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting

arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.

4. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Product Schedule: List the following for each enclosed controller:

1. Each installed magnetic controller type.
2. NRTL listing.
3. Factory-installed accessories.
4. Nameplate legends.
5. SCCR of integrated unit.
6. For each combination magnetic controller include features, characteristics, ratings, and factory setting of the SCPD and OCPD.
  - a. Listing document proving Type 2 coordination.
7. For each series-rated combination state the listed integrated short-circuit current (withstand) rating of SCPD and OCPDs by an NRTL acceptable to authorities having jurisdiction.

#### 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Seismic Qualification Data: Certificates, for magnetic controllers, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

#### 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For magnetic controllers to include in operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
  - a. Routine maintenance requirements for magnetic controllers and installed components.
  - b. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
  - c. Manufacturer's written instructions for setting field-adjustable overload relays.
  - d. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
  - e. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.



## 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  - 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
  - 3. Indicating Lights: Two of each type and color installed.
  - 4. Auxiliary Contacts: Furnish one spare for each size and type of magnetic controller installed.
  - 5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

## 1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
  - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

## 1.10 FIELD CONDITIONS

- A. Ambient Environment Ratings: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - 1. Ambient Temperature: Not less than 23 deg F (minus 5 deg C) and not exceeding 104 deg F (40 deg C).
  - 2. Altitude: Not exceeding 6600 feet (2010 m) for electromagnetic and manual devices.
  - 3. The effect of solar radiation is not significant.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. UL Compliance: Fabricate and label magnetic motor controllers to comply with UL 508 and UL 60947-4-1.
- C. NEMA Compliance: Fabricate motor controllers to comply with ICS 2.
- D. Seismic Performance: Magnetic controllers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the controller will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Component Importance Factor: 1.5.

## 2.2 MANUAL MOTOR CONTROLLERS

- A. Motor-Starting Switches (MSS): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Eaton.
    - b. Siemens Industry, Inc., Energy Management Division.
    - c. Square D; Schneider Electric USA.
  2. Standard: Comply with NEMA ICS 2, general purpose, Class A.
  3. Configuration: Nonreversing or reversing as required.
  4. Surface mounting.
  5. Red and Greenpilot light.
- B. Fractional Horsepower Manual Controllers (FHPMC): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Eaton.
    - b. Siemens Industry, Inc., Energy Management Division.
    - c. Square D; Schneider Electric USA.
  2. Configuration: Nonreversing.
  3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
  4. Overload Relays: NEMA ICS 2, bimetallic class as schedule on Drawings.
  5. Pilot Light: Red.
- C. Integral Horsepower Manual Controllers (IHPMC): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Eaton.
    - b. Siemens Industry, Inc., Energy Management Division.
    - c. Square D; Schneider Electric USA.
  2. Configuration: Nonreversing.
  3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
  4. Overload Relays: NEMA ICS 2, bimetallic class as scheduled on Drawings.

## 2.3 ENCLOSED FULL-VOLTAGE MAGNETIC MOTOR CONTROLLERS

- A. Description: Across-the-line start, electrically held, for nominal system voltage of 600-V ac and less.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton.
  - 2. Siemens Industry, Inc., Energy Management Division.
  - 3. Square D; Schneider Electric USA.
- C. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- D. Configuration: Nonreversing.
- E. Contactor Coils: Pressure-encapsulated type with coil transient suppressors when indicated.
  - 1. Operating Voltage: Manufacturer's standard, unless indicated.
- F. Control Power:
  - 1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
    - a. Spare CPT Capacity as Indicated on Drawings: 50 VA.
- G. Overload Relays:
  - 1. Thermal Overload Relays:
    - a. Inverse-time-current characteristic.
    - b. Class 10 tripping characteristic.
    - c. Heaters in each phase shall be matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
    - d. Ambient compensated.
    - e. Automatic resetting.
  - 2. Solid-State Overload Relay:
    - a. Switch or dial selectable for motor-running overload protection.
    - b. Sensors in each phase.
    - c. Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
    - d. Class II ground-fault protection shall comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system shall include circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.
- H. Digital communication module, using RS-485 Modbus, RTU protocol, 4-wire connection to host devices with a compatible port to transmit the following to the LAN:
  - 1. Instantaneous rms current each phase, and 3-phase average.

2. Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.
3. Active Energy (kWh): 3-phase total.
4. Power Factor: Each phase and 3-phase total.

#### 2.4 COMBINATION FULL-VOLTAGE MAGNETIC MOTOR CONTROLLER

- A. Description: Factory-assembled, combination full-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, SCPD and OCPD, in a single enclosure.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Eaton.
  2. Siemens Industry, Inc., Energy Management Division.
  3. Square D; Schneider Electric USA.
- C. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- D. Configuration: Nonreversing.
- E. Contactor Coils: Pressure-encapsulated type with coil transient suppressors when indicated.
  1. Operating Voltage: Manufacturer's standard, unless indicated.
- F. Control Power:
  1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
    - a. Spare CPT Capacity as Indicated on Drawings: 50 VA.
- G. Overload Relays:
  1. Thermal Overload Relays:
    - a. Inverse-time-current characteristic.
    - b. Class 10 tripping characteristic.
    - c. Heaters in each phase shall be matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
    - d. Ambient compensated.
    - e. Automatic resetting.
  2. Solid-State Overload Relay:
    - a. Switch or dial selectable for motor-running overload protection.
    - b. Sensors in each phase.
    - c. Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
- H. Class II ground-fault protection shall comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system shall include circuitry that will prevent the motor controller

from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.

- I. Digital communication module, using RS-485 Modbus, RTU protocol, 4-wire connection to host devices with a compatible port to transmit the following to the LAN:
  - 1. Instantaneous rms current each phase, and 3-phase average.
  - 2. Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.
  - 3. Active Energy (kWh): 3-phase total.
  - 4. Power Factor: Each phase and 3-phase total.
- J. Fusible Disconnecting Means:
  - 1. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
  - 2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
- K. Nonfusible Disconnecting Means:
  - 1. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
  - 2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
- L. MCP Disconnecting Means:
  - 1. UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
  - 2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
- M. MCCB Disconnecting Means:
  - 1. UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse-time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
  - 2. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  - 3. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

## 2.5 ENCLOSURES

- A. Comply with NEMA 250, type designations as indicated on Drawings, complying with environmental conditions at installed location.
- B. The construction of the enclosures shall comply with NEMA ICS 6.
- C. Controllers in hazardous (classified) locations shall comply with UL 1203.

## 2.6 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
  - 1. Push Buttons, Pilot Lights, and Selector Switches: Standard-duty, except as needed to match enclosure type. Heavy-duty or oil-tight where indicated in the controller schedule.

- a. Push Buttons: As indicated in the controller schedule.
    - b. Pilot Lights: As indicated in the controller schedule.
  - 2. Elapsed Time Meters: Heavy duty with digital readout in hours; resettable.
  - 3. Meters: Panel type, 2-1/2-inch (64-mm) minimum size with 90- or 120-degree scale and plus or minus two percent accuracy. Where indicated, provide selector switches with an off position.
- B. Motor protection relays shall be with solid-state sensing circuit and isolated output contacts for hardwired connections.
- 1. Phase-failure.
  - 2. Phase-reversal, with bicolor LED to indicate normal and fault conditions. Automatic reset when phase reversal is corrected.
  - 3. Under/overvoltage, operate when the circuit voltage reaches a preset value, and drop out when the operating voltage drops to a level below the preset value. Include adjustable time-delay setting.
- C. Breather assemblies, to maintain interior pressure and release condensation in Type 4 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- D. Space heaters, with NC auxiliary contacts, to mitigate condensation in Type 3R enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- E. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

## 2.7 IDENTIFICATION

- A. Controller Nameplates: as described in Section 260553 "Identification for Electrical Systems," for each compartment, mounted with corrosion-resistant screws.
- B. Arc-Flash Warning Labels:
- 1. Comply with requirements in Section 260573.19 "Arc-Flash Hazard Analysis." Produce a 3.5-by-5-inch (89-by-127-mm) self-adhesive equipment label for each work location included in the analysis.
  - 2. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce a 3.5-by-5-inch (89-by-127-mm) self-adhesive equipment label for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.
    - a. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
      - 1) Location designation.
      - 2) Nominal voltage.
      - 3) Flash protection boundary.
      - 4) Hazard risk category.
      - 5) Incident energy.
      - 6) Working distance.
      - 7) Engineering report number, revision number, and issue date.

- b. Labels shall be machine printed, with no field-applied markings.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

#### 3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Wall-Mounted Controllers: Install magnetic controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems" unless otherwise indicated.
- C. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- D. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- E. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- F. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

#### 3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

#### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections:
  - 1. Comply with the provisions of NFPA 70B, "Testing and Test Methods" Chapter.
  - 2. Visual and Mechanical Inspection:
    - a. Compare equipment nameplate data with drawings and specifications.
    - b. Inspect physical and mechanical condition.

- c. Inspect anchorage, alignment, and grounding.
  - d. Verify the unit is clean.
  - e. Inspect contactors:
    - 1) Verify mechanical operation.
    - 2) Verify contact gap, wipe, alignment, and pressure are according to manufacturer's published data.
  - f. Motor-Running Protection:
    - 1) Verify overload element rating is correct for its application.
    - 2) If motor-running protection is provided by fuses, verify correct fuse rating.
  - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
    - 1) Use a low-resistance ohmmeter. Compare bolted connection resistance values with values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
  - h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
3. Electrical Tests:
- a. For the contactor and circuit breaker, perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Insulation-resistance values shall be according to manufacturer's published data or NETA ATS Table 100.1. In the absence of manufacturer's published data, use Table 100.5. Values of insulation resistance less than those of this table or manufacturer's recommendations shall be investigated and corrected.
  - b. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
  - c. Test motor protection devices according to manufacturer's published data.
  - d. Test circuit breakers as follows:
    - 1) Operate the circuit breaker to ensure smooth operation.
    - 2) For adjustable circuit breakers, adjust protective device settings according to the coordination study. Comply with coordination study recommendations.
  - e. Perform operational tests by initiating control devices.
4. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove all necessary covers prior to the inspection.
- a. Comply with the recommendations of NFPA 70B, "Testing and Test Methods" Chapter, "Infrared Inspection" Article.



- b. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of each motor controller.
- c. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each motor controller 11 months after date of Substantial Completion.
- d. Report of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used, and lists the following results:
  - 1) Description of equipment to be tested.
  - 2) Discrepancies.
  - 3) Temperature difference between the area of concern and the reference area.
  - 4) Probable cause of temperature difference.
  - 5) Areas inspected. Identify inaccessible and unobservable areas and equipment.
  - 6) Load conditions at time of inspection.
  - 7) Photographs and thermograms of the deficient area.
  - 8) Recommended action.
- e. Equipment: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C. The equipment shall detect emitted radiation and convert detected radiation to a visual signal.
- f. Act on inspection results and recommended action, and considering the recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

F. Motor controller will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

### 3.5 SYSTEM FUNCTION TESTS

A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality control tests have been completed and all components have passed specified tests.

- 1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
- 2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
- 3. Verify the correct operation of sensing devices, alarms, and indicating devices.

B. Motor controller will be considered defective if it does not pass the system function tests and inspections.

C. Prepare test and inspection reports.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchgear.

END OF SECTION

## SECTION 262913.06

### SOFT-START MOTOR CONTROLLERS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.

##### 1.2 SUMMARY

- A. Section includes soft-start motor controllers that are designed for reduced-voltage start and full-voltage run duty.
  - 1. Enclosed soft-start controllers.
  - 2. Combination soft-start controllers.
  - 3. Enclosures.
  - 4. Accessories.
  - 5. Identification.

##### 1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. FLA: Full-load current.
- C. MCCB: Molded-case circuit breaker.
- D. MCP: Motor circuit protector.
- E. NC: Normally closed.
- F. NO: Normally open.
- G. OCPD: Overcurrent protective device.
- H. SCCR: Short-circuit current rating.
- I. SCPD: Short-circuit protective device.
- J. SCR: Silicon-controlled rectifier.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For each type of controller.

1. Include plans, elevations, sections, and mounting details.
2. Indicate dimensions, weights, required clearances, and location and size of each field connection.
3. Wire Termination Diagrams and Schedules: Include diagrams for signal and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
4. Include features, characteristics, ratings, and factory settings of individual OCPD and auxiliary components.

C. Product Schedule: For each enclosed controller.

1. Each installed soft-start controller type.
2. NRTL listing.
3. Factory-installed accessories.
4. Nameplate legends.
5. SCCR of integrated unit.
  - a. For each combination soft-start controller, include features, characteristics, ratings, and factory setting of the SCPD and OCPD.
    - 1) Listing document proving Type 2 coordination.
  - b. For each series-rated combination, state the listed integrated SCCR (withstand) of SCPDs and OCPDs by an NRTL acceptable to authorities having jurisdiction.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Seismic Qualification Data: Certificates, for soft-start controllers, from manufacturer.
  1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
  3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Source quality-control reports.
- D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For soft-start controllers to include in operation and maintenance manuals.
  1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
    - a. Routine maintenance requirements for soft-start controllers and installed components.

- b. Manufacturer's written instructions for testing and adjusting circuit-breaker and MCP trip settings.
- c. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage soft-start controllers.
- d. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate FLAs.
- e. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  - 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
  - 3. Indicating Lights: Two of each type and color installed.
  - 4. Auxiliary Contacts: Furnish one spare for each size and type of magnetic controller installed.
  - 5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

#### 1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
  - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

#### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store soft-start controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect soft-start controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

#### 1.10 FIELD CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - 1. Ambient Temperature: Not less than 32 deg F (0 deg C) and not exceeding 104 deg F (40 deg C), humidity noncondensing.
  - 2. Altitude: Not exceeding 3300 feet (1000 m).
  - 3. The effect of solar radiation is insignificant.

### PART 2 - PRODUCTS

#### 2.1 MOTOR CONTROLLER PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

- B. UL Compliance: Fabricate and label enclosed controllers to comply with UL 508.
- C. NEMA Compliance: Fabricate motor controllers to comply with NEMA ICS 2.
- D. Seismic Performance: Soft-start controllers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  - 2. Component Importance Factor: 1.5.

## 2.2 ENCLOSED SOFT-START MOTOR CONTROLLERS

- A. Description: Controllers designed for reduced-voltage start, full-voltage run, and optional soft stop. The controller shall be an integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and user interface module, run-bypass contactor, and overload relay(s); suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.
  - 1. Run-Bypass Contactor: Magnetic contactor in parallel with the SCR of the soft-start controller, bypassing the SCR when full voltage is achieved.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton.
  - 2. Siemens Industry, Inc., Energy Management Division.
  - 3. Square D; Schneider Electric USA.
- C. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- D. Configuration: Standard duty.
  - 1. At least two SCRs per phase to control the starting and stopping of the motor.
  - 2. Microprocessor control shall continuously monitor current and proper operation of the SCRs.
  - 3. Bypass Contactor: Operates automatically when full voltage is applied to motor and bypasses the SCRs. Soft-start controller protective features and deceleration controls shall remain active when this contactor is in the bypass mode.
  - 4. Power Electronics Disconnect Contactor. Where indicated, installed ahead of the power electronics equipment, and shall open automatically when the motor is stopped, or a controller fault is detected, or when an SCR shorts.
  - 5. Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.
  - 6. Surge Protection: Comply with NEMA ICS 2 requirements for surge suppression.
- E. Control Power:
  - 1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
  - 2. Spare CPT Capacity: As indicated on Drawings, available in increments of 100 VA, from 100 to 500 VA.

- F. Controller Diagnostics and Protection:
1. Microprocessor-based thermal-protection system for monitoring SCR and motor thermal characteristics and providing controller overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
  2. Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and under-load conditions; and line frequency over or under normal.
  3. Input isolation contactor that opens when the controller diagnostics detect a faulted soft-start component or when the motor is stopped.
- G. Cover mounted-controller status panel with LED lights or alphanumeric display to show the following:
1. Starter Status: "Ready," "starting," "stopping," or "run."
  2. Motor current in amperes.
  3. Faults:
    - a. Motor overcurrent trip.
    - b. Motor thermal overload.
    - c. Starter thermal fault.
    - d. Low line voltage.
    - e. Loss of a phase.
    - f. Phases reversed.
    - g. Maximum starting time exceeded.
    - h. Serial communications error.
- H. Interface Panel: Mounted on controller door.
1. Guarded adjustable set points, not readily accessible.
    - a. Motor FLA, adjustable from [0 to 110 percent of the controller's rating.
    - b. Current limitation on starting, adjustable from 200 to 500 percent of FLA, typically set at 300 percent.
    - c. NEMA ICS 2 overload class. Selections shall include the following tripping classes: Class 5, Class 10, Class 15, Class 20, and Class 30.
  2. Adjustable set points, readily accessible, password protected.
    - a. Linear acceleration, adjustable from 1 to 60 s.
    - b. Maximum start time, adjustable from 1 to 250 s.
    - c. Selector switch: select coast to stop or soft stop.
    - d. Linear deceleration, adjustable from 1 to 60 s.
- I. Remote Output Features. All outputs shall be prewired to terminal blocks.
1. Analog output for field-selectable assignment of motor operating characteristics; 0- to 10-V dc.
  2. Form C status contacts that change state when controller is running.
  3. Form C alarm contacts that change state when a fault condition occurs.
- J. Digital Communication Module: RS-485 Modbus, RTU protocol, 4-wire connection to host devices with a compatible port to transmit the following to the LAN:
1. Instantaneous root mean square (rms) current each phase, and three-phase average.

2. Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average - rms.
3. Active Energy (kilowatt-hour): Three-phase total.
4. Power Factor: Each phase and three-phase total.

### 2.3 COMBINATION SOFT-START MOTOR CONTROLLERS

- A. Description: Factory-assembled, combination, reduced-voltage soft-start controller with a disconnecting means, SCPD and OCPD, in a single enclosure. The reduced-voltage soft-start controller shall consist of an integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and user interface module, run-bypass contactor, and overload relay(s); suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.
  1. Run-Bypass Contactor: Magnetic contactor in parallel with the SCR of the soft-start controller, bypassing the SCR when full voltage is achieved.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Eaton.
  2. Siemens Industry, Inc., Energy Management Division.
  3. Square D; Schneider Electric USA.
- C. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- D. Configuration: Standard duty.
  1. At least two SCRs per phase to control the starting and stopping of the motor.
  2. Microprocessor control shall continuously monitor current and proper operation of the SCRs.
  3. Bypass Contactor: Operates automatically when full voltage is applied to motor and bypasses the SCRs. Soft-start controller protective features and deceleration controls shall remain active when this contactor is in the bypass mode.
  4. Power Electronics Disconnect Contactor. Where indicated, installed ahead of the power electronics equipment, and shall open automatically when the motor is stopped, or a controller fault is detected, or when an SCR shorts.
  5. Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.
  6. Surge Protection: Comply with NEMA ICS 2 requirements for surge suppression.
- E. Control Power:
  1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
  2. Spare CPT Capacity: As indicated on Drawings, available in increments of 100 VA, from 100 to 500 VA.
- F. Controller Diagnostics and Protection:
  1. Microprocessor-based thermal-protection system for monitoring SCR and motor thermal characteristics and providing controller overtemperature and motor-overload alarm and trip; settings selectable via the keypad.



2. Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and under-load conditions; and line frequency over or under normal.
  3. Input isolation contactor that opens when the controller diagnostics detect a faulted soft-start component or when the motor is stopped.
- G. Cover mounted-controller status panel with LED lights or alphanumeric display to show the following:
1. Starter Status: "Ready," "starting," "stopping," or "run."
  2. Motor current in amperes.
  3. Faults:
    - a. Motor overcurrent trip.
    - b. Motor thermal overload.
    - c. Starter thermal fault.
    - d. Low line voltage.
    - e. Loss of a phase.
    - f. Phases reversed.
    - g. Maximum starting time exceeded.
    - h. Serial communications error.
- H. Interface Panel: Mounted on controller door.
1. Guarded adjustable set points, not readily accessible.
    - a. Motor FLA, adjustable from 40 to 110 percent of the controller's rating.
    - b. Current limitation on starting, adjustable from 200 to 500 percent of FLA, typically set at 300 percent.
    - c. NEMA ICS 2 overload class. Selections shall include the following tripping classes: Class 5, Class 10, Class 15, Class 20, and Class 30.
  2. Adjustable set points, readily accessible, password protected.
    - a. Linear acceleration, adjustable from 1 to 60 s.
    - b. Maximum start time, adjustable from 1 to 250 s.
    - c. Selector switch: select coast to stop or soft stop.
    - d. Linear deceleration, adjustable from 1 to 60 s.
- I. Remote Output Features: All outputs shall be prewired to terminal blocks.
1. Analog output for field-selectable assignment of motor operating characteristics; 0- to 10-V dc.
  2. Form C status contacts that change state when controller is running.
  3. Form C alarm contacts that change state when a fault condition occurs.
- J. Digital Communication Module: RS-485 Modbus, RTU protocol, 4-wire connection to host devices with a compatible port to transmit the following to the LAN:
1. Instantaneous rms current each phase, and three-phase average.
  2. Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average - rms.
  3. Active Energy (kilowatt-hour): Three-phase total.
  4. Power Factor: Each phase and three-phase total.
- K. Fusible Disconnecting Means:

1. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class J and Class L fuses.
2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
3. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.

L. MCP Disconnecting Means:

1. UL 489 and NEMA AB 3 (with interrupting capacity to comply with available fault currents) instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
3. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
4. NO alarm contact that operates only when MCP has tripped.
  - a. Current-limiting module to increase controller SCCR (withstand) to 100 kA.

M. MCCB Disconnecting Means:

1. UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
2. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
3. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
4. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
5. NO alarm contact that operates only when MCCB has tripped.

N. Molded-Case Switch Disconnecting Means:

1. UL 489 and NEMA AB 3, with in-line fuse block for Class J or Class L power fuses (depending on ampere rating), providing an interrupting capacity to comply with available fault currents; MCCB with fixed, high-set instantaneous trip only.
2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
3. Auxiliary contacts "a" and "b" arranged to activate with molded-case switch handle.
4. NO alarm contact that operates only when molded-case switch has tripped.

## 2.4 ENCLOSURES

- A. Comply with NEMA 250, Type designations as indicated on Drawings, to comply with environmental conditions at installed location.
- B. Construction of the enclosures shall comply with NEMA ICS 6.
- C. Controllers in hazardous (classified) locations shall comply with UL 1203.

## 2.5 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
  1. Push Buttons, Pilot Lights, and Selector Switches: Standard duty, except as needed to match enclosure type. Heavy-duty or oiltight where indicated in the controller schedule.
    - a. Push Buttons: As indicated in the controller schedule.
    - b. Pilot Lights: As indicated in the controller schedule.

2. Elapsed Time Meters: Heavy duty with digital readout in hours; resettable.
3. Meters: Panel type, 2-1/2-inch (64-mm) minimum size with 90- or 120-degree scale and plus or minus 2 percent accuracy. Where indicated, provide selector switches with an off position.

- B. Breather assemblies, to maintain interior pressure and release condensation in Type 4 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- C. Space heaters, with NC auxiliary contacts, to mitigate condensation in Type 3R enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- D. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

## 2.6 IDENTIFICATION

- A. Controller Nameplates: signs, as described in Section 260553 "Identification for Electrical Systems," for each compartment, mounted with corrosion-resistant screws.
- B. Arc-Flash Warning Labels:
  1. Comply with requirements in Section 260573.19 "Arc-Flash Hazard Analysis." Produce a 3-1/2-by-5-inch (89-by-127-mm) self-adhesive label for each work location included in the analysis.
  2. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce a 3-1/2-by-5-inch (89-by-127-mm) self-adhesive equipment label for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.
    - a. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
      - 1) Location designation.
      - 2) Nominal voltage.
      - 3) Flash protection boundary.
      - 4) Hazard risk category.
      - 5) Incident energy.
      - 6) Working distance.
      - 7) Engineering report number, revision number, and issue date.
    - b. Labels shall be machine printed, with no field-applied markings.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

### 3.2 INSTALLATION

- A. Comply with NECA 1.

- B. Wall-Mounted Controllers: Install controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on slotted support systems complying with Section 260529 "Hangers and Supports for Electrical Systems," and bolted to wall.
- C. Freestanding Controllers: Provide slotted support systems complying with Section 260529 "Hangers and Supports for Electrical Systems."
- D. Floor-Mounted Controllers: Install controllers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
- E. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- F. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- G. Control Wiring: Separate control wiring from power wiring. Where unavoidable, use twisted pair cabling or shielded cables for control wiring.
- H. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- I. Setting of Overload Relays: Select and set overloads on the basis of FLA rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for high-torque, high-efficiency, and so on motors.

### 3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections:
  1. Comply with provisions of NFPA 70B, Chapter "Testing and Test Methods."
  2. Visual and Mechanical Inspection:
    - a. Compare equipment nameplate data with Drawings and the Specifications.
    - b. Inspect physical and mechanical condition.
    - c. Inspect anchorage, alignment, and grounding.
    - d. Verify that the unit is clean.
    - e. Ensure that vent path openings are free from debris and that heat-transfer surfaces are clean.

- f. Verify correct connections of circuit boards, wiring, disconnects, and ribbon cables.
  - g. Inspect Contactors:
    - 1) Verify mechanical operation.
    - 2) Verify that contact gap, wipe, alignment, and pressure are according to manufacturer's published data.
  - h. Motor-Running Protection:
    - 1) Verify that motor FLA is at, or under, the controller current rating.
    - 2) Verify that overload element setting is correct for its application.
    - 3) Apply minimum- and maximum-speed set points. Verify that set points are within limitations of the load coupled to the motor.
    - 4) If motor-running protection is provided by fuses, verify correct fuse rating.
  - i. Inspect bolted electrical connections for high resistance using one of the following two methods:
    - 1) Use a low-resistance ohmmeter. Compare bolted-connection-resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
  - j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
3. Electrical Tests:
- a. For the contactor and circuit breaker, perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Insulation-resistance values shall be according to manufacturer's published data or NETA ATS, Table 100.1. In the absence of manufacturer's published data, use Table 100.5. Values of insulation resistance less than this table or manufacturer's written instructions shall be investigated and corrected.
  - b. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
  - c. Test motor protection devices according to manufacturer's published data.
  - d. Test circuit breakers as follows:
    - 1) Operate the circuit breaker to ensure smooth operation.
    - 2) For adjustable circuit breakers, adjust protective device settings according to the coordination study. Comply with coordination study recommendations.
  - e. Test the electronic motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.
  - f. Test the following parameters according to NETA relay calibration procedures, or as recommended by manufacturer:
    - 1) ANSI No. 49R, Overtemperature Protection:

- a) Determine time delay at 300 percent of setting.
      - b) Determine a second point on the operating curve.
      - c) Determine pickup.
    - 2) ANSI No. 47, Input Phase Loss and Reversed Phases Protection:
      - a) Determine positive sequence voltage to close the NO contact.
      - b) Determine positive sequence voltage to open the NC contact (undervoltage trip).
      - c) Verify negative sequence trip.
      - d) Determine time delay to close the NO contact with sudden application of 120 percent of pickup.
      - e) Determine time delay to close the NC contact on removal of voltage when previously set to rated system voltage.
    - 3) ANSI No. 81, Overfrequency Protection:
      - a) Verify frequency set points.
      - b) Determine time delay.
      - c) Determine undervoltage cutoff.
    - 4) Fault Alarm Outputs: Verify that each relay contact performs its intended function in the control scheme including breaker trip tests, close inhibit tests, lockout tests, and alarm functions.
  - g. Perform operational tests by initiating control devices.
4. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove all necessary covers prior to the inspection.
  - a. Comply with recommendations of NFPA 70B, Chapter "Testing and Test Methods," Article "Infrared Inspection."
  - b. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of each motor controller.
  - c. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each motor controller 11 months after date of Substantial Completion.
  - d. Report of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used, and lists the following results:
    - 1) Description of equipment to be tested.
    - 2) Discrepancies.
    - 3) Temperature difference between the area of concern and the reference area.
    - 4) Probable cause of temperature difference.
    - 5) Areas inspected. Identify inaccessible and unobservable areas and equipment.
    - 6) Identify load conditions at time of inspection.
    - 7) Provide photographs and thermograms of the deficient area.
    - 8) Recommended action.
  - e. Equipment: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C. The equipment shall detect emitted radiation and convert detected radiation to a visual signal.

- f. Act on inspection results, recommended action, and considering recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

F. Motor controllers will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

### 3.5 SYSTEM FUNCTION TESTS

A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality-control tests have been completed and all components have passed specified tests.

1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
3. Verify the correct operation of sensing devices, alarms, and indicating devices.

B. Motor controllers will be considered defective if they do not pass the system function tests and inspections.

C. Prepare test and inspection reports.

### 3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor controllers.

END OF SECTION

## SECTION 263213

### GAS-ENGINE-DRIVEN GENERATOR SETS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements or Electrical," apply to this Section.

##### 1.2 SUMMARY

###### A. Section Includes:

1. Engine.
2. Gas fuel system.
3. Control and monitoring.
4. Generator overcurrent and fault protection.
5. Generator, exciter, and voltage regulator.
6. Battery Charger
7. Outdoor generator-set enclosure.
8. Vibration isolation devices.

###### B. Related Requirements:

1. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

##### 1.3 DEFINITIONS

A. EPS: Emergency power supply.

B. EPSS: Emergency power supply system.

C. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

##### 1.4 ACTION SUBMITTALS

###### A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Include thermal damage curve for generator.
3. Include time-current characteristic curves for generator protective device.
4. Include fuel consumption in cubic feet per hour (cubic meters per hour) at 0.8 power factor at 0.5, 0.75 and 1.0 times generator capacity.
5. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.



6. Include air flow requirements for cooling and combustion air in cfm at 0.8 power factor, with air supply temperature of 95 deg F, 80 deg F, 70 deg F, and 50 deg F. Provide drawings showing requirements and limitations for location of air intake and exhausts.
7. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.

B. Shop Drawings:

1. Include plans and elevations for engine generator and other components specified.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Identify fluid drain ports and clearance requirements for proper fluid drain.
4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.
6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment and functional relationship between all electrical components.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer manufacturer and testing agency.

B. Seismic Qualification Data: Certificates, for engine generator, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: With engine and generator mounted on rails, identify center of gravity and total weight, supplied enclosure, external silencer, and each piece of equipment not integral to the engine generator, and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source Quality-Control Reports: Including, but not limited to, the following:

1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads and life safety.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

D. Field quality-control reports.

E. Warranty: For special warranty.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For engine generators to include in emergency, operation, and maintenance manuals.
  - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
    - a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
    - b. Operating instructions laminated and mounted adjacent to generator location.
    - c. Training plan.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
  - 2. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
  - 3. Tools: Each tool listed by part number in operations and maintenance manual.

## 1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Testing Agency Qualifications: Accredited by NETA.
  - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

## 1.9 PERMITS, FILINGS AND MISCELLANEOUS REGULATORY REQUIREMENTS:

- A. File for and obtain all required Federal, State and local environmental, air quality, and other specialty permits, registrations, and other regulatory requirements for the installation of the generator, generator exhaust system, generator fuel supply and storage system, and other generator system components. All such filings shall be made on behalf of and in the name of the Owner. Provide copies of all such submissions to the Owner and to the Engineer for their record.
- B. Compile all such submissions and certifications in a separate 3-ring binder similar to those used for the project Operation and Maintenance Manuals. Include a schedule of required resubmission and renewal dates for the Owner's guidance and information. This shall include all required forms, and the agency, including proper filing address, to which the renewals must be submitted. The schedule shall be for a minimum duration of five (5) years from the date of project Substantial Completion.
- C. All costs for such regulatory filings shall be included in the project bid.

## 1.10 WARRANTY:

- A. Special Warranty Requirements: The complete electrical power generation system (generator set, controls, and associated switches, automatic transfer switches and accessories), shall be warranted for a period of not less than 5 years from the date of final commissioning against

defects in materials and workmanship. Coverage shall include parts, travel expenses, and labor to remove/reinstall the equipment, per the manufacturer's standard published warranty. There shall be no deductibles applied to the warranty.

- B. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Generators shall be Caterpillar, Inc.; Electric Power Division, which shall be the basis of design. The basis of generator design are CAT G3520 2000ekW (STBY/Fast Response) Natural Gas Generator Packages. Subject to compliance with all contract requirements, substitutions may be considered from one of the following:
  - 1. Cummins Power Generation.
  - 2. Kohler Power Systems.
  - 3. Rolls-Royce Solutions America Inc. (MTU)
- B. Source Limitations: Obtain packaged engine generators and auxiliary components through one source from a single manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Engine generator housing, engine generator, batteries, battery racks, silencers, and sound attenuating equipment, accessories, and components shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
  - 2. Shake-table testing shall comply with ICC-ES AC156. Testing shall be performed with all fluids at worst-case normal levels.
  - 3. Component Importance Factor: 1.5.
- B. B11 Compliance: Comply with B11.19.
- C. NFPA Compliance:
  - 1. Comply with NFPA 37.
  - 2. Comply with NFPA 70.
  - 3. Comply with NFPA 99.
  - 4. Comply with NFPA 110 requirements for Level 1 EPSS.
- D. UL Compliance: Comply with UL 2200.
- E. Engine Exhaust Emissions: Comply with EPA JJJJ NSPS standards requirements and applicable state and local government requirements.
- F. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by engine generator including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

- G. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
  - 1. Ambient Temperature: 41 to 104 deg F.
  - 2. Relative Humidity: Zero to 95 percent.
  - 3. Altitude: Sea level to 1000 feet.

## 2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

- A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and use.
- C. Power Rating: Standby.
- D. Overload Capacity: No overload capacity for standby rated generator. Rated for average loading of 70% of rating with intermittent loading up to 100% of rating.
- E. EPSS Class: Engine generator shall be classified as Class 96 according to NFPA 110.
- F. Power Factor: 0.8, lagging.
- G. Frequency: 60 Hz.
- H. Voltage: 480 V ac.
- I. Phase: Three-phase, six wire, wye.
- J. Induction Method: Turbocharged.
- K. Governor: Adjustable isochronous, with speed sensing.
- L. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.
  - 1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.
- M. Capacities and Characteristics:
  - 1. Power Output Ratings: As indicated on the drawings.
  - 2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
- N. Engine Generator Performance:
  - 1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.

2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
  - a. Provide permanent magnet excitation for power source to voltage regulator
9. Start Time:
  - a. Comply with NFPA 110, Type 10 system requirements.

## 2.4 GAS ENGINE

- A. Fuel: Natural gas.
- B. Rated Engine Speed: 1800 rpm.
- C. Lubrication System: Engine or skid-mounted.
  1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
  2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
  3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
  4. Engine mounted fuel oil cooler, if recommended by the engine manufacturer.
    - a. Provide a valved, piped engine lubrication oil drain, piped to a point outside the generator weather-resistant housing readily accessible for maintenance. This drain shall be suitably mounted so as to be free from all vibrational stress. The drain system shall consist of a brass body gate valve at the engine lubrication oil drain outlet, and a section of flexible metal braided hose. The hose shall have an outer braided metal covering and shall be of material which is compatible with lubrication oil. The hose shall be of sufficient length to extend a minimum of 6" beyond the generator concrete pad, and shall be terminated with suitable brass end fittings. Furnish a 2" diameter hole through the generator mounting skid for passage of the generator lubrication oil drain line. This hose shall be provided with a suitable bushing, nipple or grommet to avoid abrasion of the drain line.

- D. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with UL 499 and with NFPA 110 requirements for Level 1 equipment for heater capacity.
- E. Integral Cooling System: Closed loop, liquid cooled, with radiator field mounted on top of generator enclosure with electrically operated fans and integral engine-driven coolant pump.
1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
  2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 100 percent load condition.
  3. Expansion Tank: If required to allow sufficient expansion of the coolant, beyond which can be accommodated by the radiator. Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
  4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
  5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
    - a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
    - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
  6. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
  7. Expansion Tank: If radiator is inadequate to contain expansion of total system coolant, provide a suitable Expansion Tank. Expansion tank shall be constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
  8. Fan: Driven by multiple belts from engine shaft.
  9. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
  10. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
- F. Muffler/Silencer:
1. Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
    - a. Minimum sound attenuation of 25 dB at 500 Hz.
    - b. Sound level measured at a distance of 25 feet from exhaust discharge after installation is complete shall be 78 dBA or less.
- G. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- H. Starting System: 24-V electric, with negative ground.
1. Components: Sized so they are not damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.

2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length required. Include required interconnecting conductors and connection accessories.
6. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.
7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35 A minimum continuous rating.
8. Battery Charger:
  - a. Provide wall mounted 20 amp voltage regulated battery charger. Input AC voltage shall be 120 volts, 1 phase. DC output voltage shall suit the engine starting battery system. Charger shall be equipped with float, taper and equalize charge settings. The battery charger shall include a microprocessor based monitoring and alarm package with field programmable settings. The monitoring and alarm package shall include the following:
    - 1) Multi-mode digital equalize timer, settings adjustable from 1-144 hours in five selectable modes: Standard, 7-day, 14-day, 30-day, and equalize after low DC voltage condition
    - 2) Combination Digital Voltmeter/Ammeter with selector switch (1% accuracy)
    - 3) Equalize LED
    - 4) Low DC current alarm LED with two form "C" contacts
    - 5) High DC voltage alarm LED with two form "C" contacts
    - 6) Low DC voltage alarm LED with two form "C" contacts
    - 7) Critical low DC voltage alarm LED with two form "C" contacts
    - 8) High voltage shutdown alarm LED with two form "C" contacts
    - 9) AC power failure alarm LED with two form "C" contacts
    - 10) Rectifier failure/summary alarm relay and two form "C" contacts
  - b. Operational monitors shall provide visual output along with individual form C contacts rated at 4 amps, 120 VAC, 30 VDC for remote indication of:
    - 1) Loss of AC power - red light
    - 2) Low battery voltage - red light
    - 3) High battery voltage - red light
    - 4) Power ON - green light (no relay contact)
  - c. Battery charger shall be La Marche Model A46 with accessories as specified herein, or approved equal.
  - d. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

## 2.5 GAS FUEL SYSTEM

- A. Natural Gas Piping: Comply with requirements in Section 231123 "Facility Natural Gas Piping."
- B. LP Gas Piping: Comply with requirements in Section 231126 "Facility Liquefied-Petroleum Gas Piping."
- C. Gas Train: Comply with NFPA 37.

- D. Engine Fuel System:
- E. Natural Gas, Vapor-Withdrawal System:
  - 1. Carburetor.
  - 2. Secondary Gas Regulators: One for each fuel type, with atmospheric vents piped to building exterior.
  - 3. Fuel-Shutoff Solenoid Valves: NRTL-listed, normally closed, safety shutoff valves; one for each fuel source.
  - 4. Fuel Filters: One for each fuel type.
  - 5. Manual Fuel Shutoff Valves: One for each fuel type.
  - 6. Flexible Fuel Connectors: Minimum one for each fuel connection.

## 2.6 CONTROL AND MONITORING

- A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates generator-set shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.
- B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts engine generator. The off position of same switch initiates generator-set shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.
- C. Provide minimum run time control set for 15 minutes with override only by operation of a remote emergency-stop switch.
- D. Comply with UL 508A.
- E. Configuration:
  - 1. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from generator-set vibration. Panel shall be powered from the engine generator battery.
  - 2. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel. Panel shall be powered from the engine generator battery.
  - 3. Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel shall be powered from the engine generator battery. Panel features shall include the following:
    - a. Wall-Mounting Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6.
- F. Control and Monitoring Panel:



1. Digital controller with integrated LCD, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
  2. Instruments: Located on the control and monitoring panel and viewable during operation.
    - a. Engine lubricating-oil pressure gage.
    - b. Engine-coolant temperature gage.
    - c. DC voltmeter (alternator battery charging).
    - d. Running-time meter.
    - e. AC voltmeter, connected to a phase selector switch.
    - f. AC ammeter, connected to a phase selector switch.
    - g. AC frequency meter.
    - h. Generator-voltage adjusting rheostat.
  3. Controls and Protective Devices: Controls, shutdown devices, and common visual alarm indication, including the following:
    - a. Cranking control equipment.
    - b. Run-Off-Auto switch.
    - c. Control switch not in automatic position alarm.
    - d. Overcrank alarm.
    - e. Overcrank shutdown device.
    - f. Low water temperature alarm.
    - g. High engine temperature prealarm.
    - h. High engine temperature.
    - i. High engine temperature shutdown device.
    - j. Overspeed alarm.
    - k. Overspeed shutdown device.
    - l. Coolant low-level alarm.
    - m. Coolant low-level shutdown device.
    - n. Coolant high-temperature prealarm.
    - o. Coolant high-temperature alarm.
    - p. Coolant low-temperature alarm.
    - q. Coolant high-temperature shutdown device.
    - r. EPS supplying load indicator.
    - s. Battery high-voltage alarm.
    - t. Low cranking voltage alarm.
    - u. Battery-charger malfunction alarm.
    - v. Battery low-voltage alarm.
    - w. Lamp test.
    - x. Contacts for local and remote common alarm.
    - y. Remote manual stop shutdown device.
    - z. Air shutdown damper alarm when used.
    - aa. Air shutdown damper shutdown device when used.
    - bb. Hours of operation.
    - cc. Engine generator metering, including voltage, current, Hz, kW, kVA, and power factor.
    - dd. Generator overcurrent protective device not closed alarm.
  4. All indicator lamps shall be LED type.
- G. Engine Generator Metering: Comply with Section 260913 "Electrical Power Monitoring and Control."
- H. Connection to Datalink:

1. A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication.
  2. Provide connections for datalink transmission of indications to remote data terminals via ModBus, Ethernet or other acceptable protocol as required by the Electrical Power Monitoring and Control system or the Building Automation System. Data system connections to terminals are covered in Section 260913 "Electrical Power Monitoring and Control." Verify exact protocol requirements and parameters with those systems prior to manufacture.
- I. Remote Alarm Annunciator: An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.
1. Overcrank alarm.
  2. Coolant low-temperature alarm.
  3. High engine temperature prealarm.
  4. High engine temperature alarm.
  5. Low lube oil pressure alarm.
  6. Overspeed alarm.
  7. Low fuel main tank alarm.
  8. Low coolant level alarm.
  9. Low cranking voltage alarm.
  10. Contacts for local and remote common alarm.
  11. Audible-alarm silencing switch.
  12. Air shutdown damper when used.
  13. Control switch not in automatic position alarm.
  14. Lamp test.
  15. Low cranking voltage alarm.
  16. Generator overcurrent protective device not closed.
- J. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.
- K. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.
- 2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION
- A. Overcurrent protective devices shall be coordinated to optimize selective tripping when a short circuit occurs.
1. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.
  2. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.
- B. Generator Overcurrent Protective Device:
1. Molded-case circuit breaker, electronic-trip type; 100 percent rated; complying with UL 489:

- a. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
  - b. Trip Settings: Selected to coordinate with generator thermal damage curve.
  - c. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
  - d. Mounting: Adjacent to or integrated with control and monitoring panel.
- C. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector performs the following functions:
- 1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms. Contacts shall be available for load shed functions.
  - 2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
  - 3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.
  - 4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.
- D. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault.
- 1. Indicate ground fault with other engine generator alarm indications.

## 2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide 12 lead alternator.
- E. Range: Provide broad range of output voltage by adjusting the excitation level.
- F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- G. Enclosure: Dripproof.
- H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified and as required by NFPA 110.
  - 1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.

2. Maintain voltage within 15 percent on one step, full load.
3. Provide anti-hunt provision to stabilize voltage.
4. Maintain frequency within 5 percent and stabilize at rated frequency within 2 seconds.

I. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

J. Subtransient Reactance: 12 percent, maximum.

## 2.9 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description:

1. Prefabricated or pre-engineered galvanized-steel-clad, integral structural-steel-framed, walk-in enclosure, erected on concrete foundation.

B. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads up to 100 mph.

C. Seismic Design: Comply with seismic requirements in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Hinged Doors: With locksets keyed to building master keying system.

E. Space Heater: Thermostatically controlled and sized to prevent condensation.

F. Lighting: Provide weather-resistant fluorescent LED lighting with 30 fc average maintained.

G. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine generator components.

H. Muffler Location: External to enclosure.

I. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
2. Ventilation: Provide temperature-controlled exhaust fan interlocked to prevent operation when engine is running.

J. Interior Lights with Switch: Factory-wired, vapor-proof fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.
2. DC lighting system for operation when remote source and generator are both unavailable.

K. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

L. Provide a load center panelboard within each generator enclosure. Panelboard shall be rated 120/208 volts, 1 phase, 3 wire, 150 amperes main lugs only. Provide branch circuits, as required, to all generator and enclosure accessories.

## 2.10 ENCLOSURE MOUNTED RADIATOR MOTORS

- A. Description: NEMA MG 1, Design B, medium induction random-wound, squirrel-cage motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- E. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- F. Temperature Rise: Match insulation rating.
- G. Code Letter Designation:
  - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
  - 2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
- H. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.
- I. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.
- J. Provide a separate 480/277 volt, 3 phase, 4 wire panelboard, mounted within the generator enclosure and fed from the generator output power. Panelboard shall be properly sized based on the radiator fans starting and operating loads.

## 2.11 VIBRATION ISOLATION DEVICES

- A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
  - 1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch-thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
  - 2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
  - 3. Minimum Additional Travel: 50 percent of required deflection at rated load.
  - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  - 6. Minimum Deflection: 1 inch.
- B. Comply with requirements in Section 232116 "Hydronic Piping Specialties" for vibration isolation and flexible connector materials for steel piping.
- C. Comply with requirements in Section 233113 "Metal Ducts" for vibration isolation and flexible connector materials for exhaust shroud and ductwork.
- D. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

## 2.12 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

## 2.13 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
  - 1. Tests: Comply with IEEE 115 and with NFPA 110, Level 1 Energy Converters.
- B. Project-Specific Equipment Tests: Before shipment, factory test engine generator and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
  - 1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
  - 2. Test generator, exciter, and voltage regulator as a unit.
  - 3. Full load run.
  - 4. Maximum power.
  - 5. Voltage regulation.
  - 6. Transient and steady-state governing.
  - 7. Single-step load pickup.
  - 8. Safety shutdown.
  - 9. Report factory test results within 10 days of completion of test.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.
- B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 404.
- B. Comply with packaged engine generator manufacturers' written installation and alignment instructions and with NFPA 110.
- C. Equipment Mounting:
  - 1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
  - 2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

3. Install engine generator in a walk-in enclosure with restrained spring isolators having a minimum deflection of 1 inch on 4-inch-high concrete base. Secure enclosure to anchor bolts installed in concrete bases. Concrete base construction is specified in Section 260548.16 "Seismic Controls for Electrical Systems."
4. Remote Radiators:
  - a. Install remote radiator with restrained spring isolators on roof equipment supports on roof of enclosure.
  - b. Coordinate size and location of roof curbs, equipment supports, and roof penetrations for remote radiators. These items are specified in Section 077200 "Roof Accessories."
- D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- E. Cooling System: Install Schedule 40, black steel piping with welded joints for cooling water piping between engine generator and remote radiator. Piping materials and installation requirements are specified in Section 232113 "Hydronic Piping."
  1. Install isolating thimbles where exhaust piping penetrates combustible surfaces. Provide a minimum of 9 inches clearance from combustibles.
  2. Insulate cooling system piping and components according to requirements in Section 230719 "HVAC Piping Insulation."
- F. Exhaust System: Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet.
  1. Install flexible connectors and steel piping materials according to requirements in Section 232116 "Hydronic Piping Specialties."
  2. Insulate muffler/silencer and exhaust system components according to requirements in Section 230719 "HVAC Piping Insulation."
  3. Install isolating thimbles where exhaust piping penetrates combustible surfaces with a minimum of 9-inch clearance from combustibles.
- G. Drain Piping: Install condensate drain piping to muffler drain outlet with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe, the full size of the drain connection, with welded joints.
- H. Gaseous Fuel Piping:
  1. Natural gas piping, valves, and specialties for gas distribution are specified in Section 231123 "Facility Natural Gas Piping."
  2. LP gas piping, valves, and specialties for gas piping are specified in Section 231126 "Facility Liquefied-Petroleum Gas Piping."
- I. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.
- B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

- C. Connect cooling-system water piping to engine generator and remote radiator with flexible connectors.
- D. Connect engine exhaust pipe to engine with flexible connector.
- E. Gaseous Fuel Connections:
  - 1. Connect fuel piping to engines with a gate valve and union and flexible connector.
  - 2. Install manual shutoff valve in a remote location to isolate gaseous fuel supply to the generator.
  - 3. Vent gas pressure regulators outside building a minimum of 60 inches from building openings.
- F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.
- H. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

### 3.4 IDENTIFICATION

- A. Identify system components according to Section 230553 "Identification for HVAC Piping and Equipment" and Section 260553 "Identification for Electrical Systems."
- B. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency:
  - 1. Engage a qualified testing agency to perform tests and inspections.
  - 2. Perform tests and inspections with the assistance of a factory-authorized service representative.
- B. Tests and Inspections:
  - 1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in the first two subparagraphs below as specified in the NETA ATS. Certify compliance with test parameters.
    - a. Visual and Mechanical Inspection:
      - 1) Compare equipment nameplate data with drawings and specifications.
      - 2) Inspect physical and mechanical condition.
      - 3) Inspect anchorage, alignment, and grounding.
      - 4) Verify the unit is clean.
    - b. Electrical and Mechanical Tests:
      - 1) Perform insulation-resistance tests in accordance with IEEE 43.



- a) Machines larger than 200 hp. Test duration shall be 10 minutes. Calculate polarization index.
      - b) Machines 200 hp or less. Test duration shall be one minute. Calculate the dielectric-absorption ratio.
    - 2) Test protective relay devices.
    - 3) Verify phase rotation, phasing, and synchronized operation as required by the application.
    - 4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
    - 5) Perform vibration test for each main bearing cap.
    - 6) Verify correct functioning of the governor and regulator.
  - 2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.
  - 3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
    - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    - c. Verify acceptance of charge for each element of the battery after discharge.
    - d. Verify that measurements are within manufacturer's specifications.
  - 4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
  - 5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
  - 6. Exhaust Emissions Test: Comply with applicable government test criteria.
  - 7. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
  - 8. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 percent and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
  - 9. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations 25 feet from edge of the generator enclosure and four on the property line, and compare measured levels with required values.
- C. Coordinate tests with tests for transfer switches and run them concurrently.
  - D. Test instruments shall have been calibrated within the last 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.
  - E. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.
  - F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

- G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- H. Remove and replace malfunctioning units and retest as specified above.
- I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- K. Infrared Scanning: After Substantial Completion, but not more than 60 days after final acceptance, perform an infrared scan of each power wiring termination and each bus connection while running with maximum load. Remove all access panels so terminations and connections are accessible to portable scanner.
  - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
  - 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - 3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.6 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

### 3.7 TRAINING AND DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.
  - 1. Provide a minimum of two (2) identical sessions for each training session, to accommodate Owner's Maintenance and Operations personnel on multiple shifts.
- B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.
- C. Coordinate this training with that for generator equipment.
- D. Video record each training session in accordance with Section 16010, paragraph, "Owner's Instructions."

END OF SECTION

SECTION 263600  
TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.

1.2 SUMMARY

- A. Section Includes:
  - 1. Contactor-type automatic transfer switches.
  - 2. Nonautomatic transfer switches.
  - 3. Transfer switch accessories.
  - 4. Portable Generator Connection Cabinets

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
  - 2. Include material lists for each switch specified.
  - 3. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
  - 4. Riser Diagram: Show interconnection wiring between transfer switches, bypass/isolation switches, annunciators, and control panels.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer-authorized service representative and testing agency.
- B. Seismic Qualification Data: Certificates, for transfer switches, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

#### 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
  - a. Features and operating sequences, both automatic and manual.
  - b. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

#### 1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications:

1. Member company of NETA.
  - a. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

#### 1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 12 months from date of final Commissioning.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NEMA ICS 1.
- C. Comply with NFPA 99.
- D. Comply with NFPA 110.
- E. Comply with UL 1008 unless requirements of these Specifications are stricter.
- F. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- G. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Short-time withstand capability for thirty (30) cycles.
- H. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- I. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- J. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.
- K. Neutral Switching: Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.
- L. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.
- M. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable with printed markers at terminations. Color-coding and wire and cable markers are specified in Section 260553 "Identification for Electrical Systems."
1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
  2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
  3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
  4. Accessible via front access.
- N. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated in the Automatic Transfer Switch Schedule on the drawings.

## 2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB, Electrification Business.
  2. ASCO Power Technologies/Schneider Electric.
  3. Caterpillar, Inc.; Electric Power Division.
  4. Cummins Power Generation.
  5. Eaton.
  6. Russelectric, Inc.
- B. Comply with Level 1 equipment according to NFPA 110.
- C. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.

2. Switch Action: Double throw; mechanically held in both directions.
  3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
  4. Conductor Connectors: Suitable for use with conductor material and sizes.
  5. Material: Hard-drawn copper, 98 percent conductivity.
  6. Main and Neutral Lugs: Mechanical type.
  7. Ground Lugs and Bus-Configured Terminators: Mechanical type.
  8. Ground bar.
  9. Connectors shall be marked for conductor size and type according to UL 1008.
- D. Refer to Schedule of Automatic Transfer Switches on the drawings for transition type required for each Automatic Transfer Switch.
1. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.
    - a. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
  2. Automatic Delayed-Transition Transfer Switches: Pauses or stops in intermediate position to momentarily disconnect both sources, with transition controlled by programming in the automatic transfer-switch controller. Interlocked to prevent the load from being closed on both sources at the same time.
    - a. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals for alternative source. Adjustable from zero to six seconds, and factory set for one second.
    - b. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
    - c. Fully automatic break-before-make operation with center off position.
  3. Automatic Closed-Transition Transfer Switches: Connect both sources to load momentarily. Transition is controlled by programming in the automatic transfer-switch controller.
    - a. Fully automatic make-before-break operation when transferring between two available power sources.
    - b. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.
    - c. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.
      - 1) Initiation occurs without active control of generator.
      - 2) Controls ensure that closed-transition load transfer closure occurs only when the two sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.
    - d. Failure of power source serving load initiates automatic break-before-make transfer.
  4. Manual Switch Operation, Load-Breaking: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

- E. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.
- F. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel; and to Elect.
- G. Automatic Transfer-Switch Controller Features:
  - 1. Controller operates through a period of loss of control power.
  - 2. Undervoltage Sensing for Each Phase of Normal and Alternate Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
  - 3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
  - 4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
  - 5. Test Switch: Simulate normal-source failure.
  - 6. Switch-Position Pilot Lights: Indicate source to which load is connected.
  - 7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
    - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
  - 8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
  - 9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
  - 10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
  - 11. Engine Shutdown Contacts:
    - a. Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
  - 12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
    - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    - b. Push-button programming control with digital display of settings.
    - c. Integral battery operation of time switch when normal control power is unavailable.
    - d. Provide on Life Safety System Automatic Transfer Switch on Emergency Bus A and Emergency Bus B.

H. Large-Motor-Load Power Transfer:

1. In-Phase Monitor: Factory-wired, internal relay controls transfer so contacts close only when the two sources are synchronized in phase and frequency. Relay shall compare phase relationship and frequency difference between normal and emergency sources and initiate transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer shall be initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
2. Motor Disconnect and Timing Relay Controls: Designated starters in loss of power scenario shall disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters shall be through wiring external to automatic transfer switch. Provide adjustable time delay between 1 and 60 seconds for reconnecting individual motor loads. Provide relay contacts rated for motor-control circuit inrush and for actual seal currents to be encountered.
3. Programmed Neutral Switch Position: Switch operator with programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Adjustable pause from 0.5 to 30 seconds minimum, and factory set for 0.5 second unless otherwise indicated. Time delay occurs for both transfer directions. Disable pause unless both sources are live.

I. All pilot and indicating lamps shall be LED type.

2.3 NONAUTOMATIC TRANSFER SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB, Electrification Business.
  2. ASCO Power Technologies/Schneider Electric.
  3. Caterpillar, Inc.; Electric Power Division.
  4. Cummins Power Generation.
  5. Eaton.
  6. Russelectric, Inc.
- B. Manual and Electrically Operated: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Manual handle provides quick-make, quick-break manual-switching action. Switch shall be capable of electrically or manually transferring load in either direction with either or both sources energized. Control circuit disconnects from electrical operator during manual operation.
- C. Double-Throw Switching Arrangement: Incapable of pauses or intermediate position stops during switching sequence.
- D. Pilot Lights:
1. LED Type
  2. Indicate source to which load is connected.
- E. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and alternative-source sensing circuits.
1. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."



2. Emergency Power Supervision: Red light with nameplate engraved "Alternative Source Available."
  3. LED Type.
- F. Unassigned Auxiliary Contacts: Switch shall have one set of normally closed contacts for each switch position, rated 10 A at 240-V ac.
- G. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
1. Switch Action: Double throw; mechanically held in both directions.
  2. Contacts: Silver composition or silver alloy for load-current switching.
  3. Conductor Connectors: Suitable for use with conductor material and sizes.
  4. Material: Hard-drawn copper, 98 percent conductivity.
  5. Main and Neutral Lugs: Mechanical type.
  6. Ground Lugs and Bus-Configured Terminators: Mechanical type.
  7. Connectors shall be marked for conductor size and type according to UL 1008.

## 2.4 TRANSFER SWITCH ACCESSORIES

### A. Bypass/Isolation Switches:

1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Comply with requirements for Level 1 equipment according to NFPA 110.
3. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:
  - a. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. Interlocks shall prevent transfer-switch operation, except for testing or maintenance, while automatic transfer switch is isolated.
  - b. Provide means to make power available to transfer-switch control circuit for testing and maintenance purposes.
  - c. Drawout Arrangement for Transfer Switch: Provide physical separation from live parts and accessibility for testing and maintenance operations. Transfer switch and bypass/isolation switch shall be in isolated compartments.
  - d. Transition:
    - 1) Provide closed-transition operation when transferring from main transfer switch to bypass/isolation switch on the same power source.
    - 2) Provide open or closed-transition operation, as indicated in the Schedule of Transfer Switches on the drawings when transferring between power sources.
  - e. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.
  - f. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.
  - g. Manual Control: Constructed so load bypass and transfer-switch isolation can be performed by one person in no more than two operations in 15 seconds or less. Operating handles shall be externally operated.

- h. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.
  - i. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.
4. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.
- B. Remote Annunciator System:
- 1. Source Limitations: Same manufacturer as transfer switch in which installed.
  - 2. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches.
  - 3. Annunciation panel display shall include the following indicators:
    - a. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
    - b. Switch position.
    - c. Switch in test mode.
    - d. Failure of communication link.
  - 4. Annunciator Panel: LED-lamp type with audible signal and silencing switch.
    - a. Indicating Lights: Grouped for each transfer switch monitored.
    - b. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
    - c. Mounting: Flush, modular, steel cabinet unless otherwise indicated.
    - d. Lamp Test: Push-to-test or lamp-test switch on front panel.
  - 5. Locate adjacent to Generator Annunciators, where shown on the drawings

## 2.5 PORTABLE GENERATOR CONNECTION CABINET

- A. Provide a pre-manufactured NEMA 3R, weather resistant cabinet on the exterior of the building for future connection of an Owner furnished portable generator set. Cabinet shall be suitable for wall mounting where indicated on drawings.
- B. The Portable Generator Connection Cabinet shall be fabricated of welded construction 12 gauge galvanized steel.
- C. The Portable Generator Connection Cabinet shall have paint finish inside and out. The paint finish shall be a minimum of three (3) coats of factory applied manufacturer's standard gray enamel over a rust-inhibiting phosphate primer, suitable for use on galvanized steel.
- D. Provide full size hinged, gasketed door on front of cabinet for access to bus bar connections. Door shall have turn handle with two-point latch and padlock provisions.
- E. Provide separate hinged, gasketed door on bottom of cabinet for passage of cables when portable generator set is connected. Cable access door shall have turn handle with two-point latch and padlock provisions.
- F. Provide two (2) padlocks, with matching keys, one for each door. Provide four (4) keys.

- G. The Portable Generator Connection Cabinet shall include separate ¼" thick tin plated copper bus bars, capacity as indicated on the drawings for each phase, neutral and ground conductor. Mount bus bars on U.L. listed flame resistant fiberglass reinforced thermoset polyester stand-off insulators. Provide engraved phenolic nameplate on interior of cabinet to clearly label each bus bar as to phase, neutral or ground connection.
- H. Provide set screw type lugs for each phase, neutral and ground conductor for feeder from Automatic Transfer Switch.
- I. Provide cam-lock type connectors for each phase, neutral and ground conductor for cables from portable generator.
- J. Provide phase rotation meter on interior of cabinet, with green pilot light to indicate proper phase rotation and red pilot light to indicate improper rotation.
- K. Portable generator connection cabinet shall be as manufactured by N.J. Sullivan Company, which shall form the Basis of Design. Subject to compliance with all contract requirements, substitutions may be considered from J.M. Gillan Company or ASCO Power Technologies/Schneider Electric.

## 2.6 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.
- B. Prepare test and inspection reports.
  - 1. For each of the tests required by UL 1008, performed on representative devices, for Life Safety (emergency) or Critical systems. Include results of test for the following conditions:
    - a. Overvoltage.
    - b. Undervoltage.
    - c. Loss of supply voltage.
    - d. Reduction of supply voltage.
    - e. Alternative supply voltage or frequency is at minimum acceptable values.
    - f. Temperature rise.
    - g. Dielectric voltage-withstand; before and after short-circuit test.
    - h. Overload.
    - i. Contact opening.
    - j. Endurance.
    - k. Short circuit.
    - l. Short-time current capability.
    - m. Receptacle withstand capability.
    - n. Insulating base and supports damage.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Floor-Mounting Switch: Anchor to floor by bolting.

1. Install transfer switches on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
3. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
4. Provide workspace and clearances required by NFPA 70.

- B. Annunciator and Control Panel Mounting: Flush in wall unless otherwise indicated.
- C. Identify components according to Section 260553 "Identification for Electrical Systems."
- D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.
- E. Comply with NECA 1.

### 3.2 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, motor controls, control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
- B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.
  1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- F. Connect twisted pair cable according to Section 260523 "Control-Voltage Electrical Power Cables."
- G. Route and brace conductors according to manufacturer's written instructions and Section 260529 "Hangers and Supports for Electrical Systems." Do not obscure manufacturer's markings and labels.
- H. Brace and support equipment according to Section 260548.16 "Seismic Controls for Electrical Systems."
- I. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 18 inches in length.

### 3.3 FIELD QUALITY CONTROL

- A. Administrant for Tests and Inspections:
  1. Engage qualified testing agency to administer and perform tests and inspections.

2. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
3. Administer and perform tests and inspections with assistance of factory-authorized service representative.

B. Tests and Inspections:

1. After installing equipment, test for compliance with requirements according to NETA ATS.
2. Visual and Mechanical Inspection:
  - a. Compare equipment nameplate data with Drawings and Specifications.
  - b. Inspect physical and mechanical condition.
  - c. Inspect anchorage, alignment, grounding, and required clearances.
  - d. Verify that the unit is clean.
  - e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
  - f. Verify that manual transfer warnings are attached and visible.
  - g. Verify tightness of all control connections.
  - h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:
    - 1) Use of low-resistance ohmmeter.
    - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.
  - i. Perform manual transfer operation.
  - j. Verify positive mechanical interlocking between normal and alternate sources.
  - k. Perform visual and mechanical inspection of surge arresters.
  - l. Inspect control power transformers.
    - 1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
    - 2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
    - 3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.
3. Electrical Tests:
  - a. Perform insulation-resistance tests on all control wiring with respect to ground.
  - b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
  - c. Verify settings and operation of control devices.
  - d. Calibrate and set all relays and timers.
  - e. Verify phase rotation, phasing, and synchronized operation.
  - f. Perform automatic transfer tests.
  - g. Verify correct operation and timing of the following functions:
    - 1) Normal source voltage-sensing and frequency-sensing relays.
    - 2) Engine start sequence.
    - 3) Time delay on transfer.
    - 4) Alternative source voltage-sensing and frequency-sensing relays.
    - 5) Automatic transfer operation.
    - 6) Interlocks and limit switch function.

- 7) Time delay and retransfer on normal power restoration.
  - 8) Engine cool-down and shutdown feature.
4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
    - a. Check for electrical continuity of circuits and for short circuits.
    - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    - c. Verify that manual transfer warnings are properly placed.
    - d. Perform manual transfer operation.
  5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.
    - a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
    - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    - c. Verify time-delay settings.
    - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    - e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
    - f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
    - g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
  6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
    - a. Verify grounding connections and locations and ratings of sensors.
- C. Coordinate tests with tests of generator and run them concurrently.
  - D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
  - E. Transfer switches will be considered defective if they do not pass tests and inspections.
  - F. Remove and replace malfunctioning units and retest as specified above.
  - G. Prepare test and inspection reports.
  - H. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

#### 3.4 TRAINING AND DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.
  1. Provide a minimum of two (2) identical sessions for each training session, to accommodate Owner's Maintenance and Operations personnel on multiple shifts.
- B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.
- C. Coordinate this training with that for generator equipment.
- D. Video record each training session in accordance with Section 16010, paragraph, "Owner's Instructions."

END OF SECTION

## SECTION 264313

### SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

###### A. Section Includes:

1. Type 1 surge protective devices.
2. Type 2 surge protective devices.
3. Enclosures.
4. Conductors and cables.

###### B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.
2. Section 262413 "Switchboards" for integral SPDs installed by switchboard manufacturer.
3. Section 262416 "Panelboards" for integral SPDs installed by panelboard manufacturer.
4. Section 262726 "Wiring Devices" for integral SPDs installed by receptacle manufacturer.

##### 1.3 DEFINITIONS

- A.  $I_n$ : Nominal discharge current.
- B. Maximum Continuous Operating Voltage (MCOV): The maximum designated RMS value of the power frequency voltage that may be continuously applied to the mode of protection of an SPD.
- C. Metal-Oxide Varistor (MOV): An electronic component with a significant bidirectional, nonlinear current-voltage characteristic.
- D. Mode(s), Modes of Protection, or Protection Modes: Electrical paths where the SPD offers defense against transient overvoltages. Examples include line to neutral (L-N), line to ground (L-G), line to line (L-L), and neutral to ground (N-G).
- E. SCCR: Short-circuit current rating.
- F. Type 1 SPDs: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device.
- G. Type 2 SPDs: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel.
- H. Voltage Protection Rating (VPR): A rating selected from UL 1449 list of preferred values assigned to each mode of protection.



#### 1.4 ACTION SUBMITTALS

##### A. Product Data:

1. For each type of product.
  - a. Include electrical characteristics, specialties, and accessories for SPDs.
  - b. Certification of compliance with UL 1449 by qualified electrical testing laboratory recognized by authorities having jurisdiction including the following information:
    - 1) Tested values for VPRs.
    - 2)  $I_n$  ratings.
    - 3) MCOV, type designations.
    - 4) OCPD requirements.
    - 5) Manufacturer's model number.
    - 6) System voltage.
    - 7) Modes of protection.

##### B. Field quality-control reports.

#### 1.5 INFORMATIONAL SUBMITTALS

##### A. Sample Warranty: For manufacturer's special warranty.

#### 1.6 WARRANTY

##### A. Special Manufacturer Extended Warranty: Manufacturer warrants that SPDs perform in accordance with specified requirements and agrees to provide repair or replacement of SPDs that fail to perform as specified within extended warranty period.

1. Initial Extended Warranty Period: Five year(s) from date of Substantial Completion, for labor, materials, and equipment.

### PART 2 - PRODUCTS

#### 2.1 TYPE 1 SURGE PROTECTIVE DEVICES (SPDs)

##### A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Schneider Electric USA, Inc.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.

##### B. Source Limitations: Obtain devices from single source from single manufacturer.

##### C. General Characteristics:

1. Reference Standards: UL 1449, Type 1.
2. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
3. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 200 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.

4. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V and 208Y/120 V, three-phase, four-wire circuits must not exceed the following:
  - a. Line to Neutral: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
  - b. Line to Line: 2000 V for 480Y/277 V and 1200 V for 208Y/120 V.
5. SCCR: Not less than 200 kA.
6. I<sub>n</sub> Rating: 20 kA.

D. Options:

1. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
2. Include indicator light display for protection status.
3. Include audible alarm.
4. Include NEMA ICS 5, dry Form C contacts rated at 2 A and 24 V(ac) for remote monitoring of protection status.
5. Include surge counter.

## 2.2 TYPE 2 SURGE PROTECTIVE DEVICES (SPDs)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Schneider Electric USA, Inc.
2. Eaton.
3. Siemens Industry, Inc., Energy Management Division.

B. Source Limitations: Obtain devices from single source from single manufacturer.

C. General Characteristics:

1. Reference Standards: UL 1449, Type 2; UL 1283.
2. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
3. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 100 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
4. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V and 208Y/120 V, three-phase, four-wire circuits must not exceed the following:
  - a. Line to Neutral: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
  - b. Line to Ground: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
  - c. Neutral to Ground: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
  - d. Line to Line: 2000 V for 480Y/277 V and 1200 V for 208Y/120 V.
5. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits must not exceed the following:
  - a. Line to Neutral: 700 V.
  - b. Line to Ground: 700 V.
  - c. Neutral to Ground: 700 V.
  - d. Line to Line: 1200 V.

6. SCCR: Equal or exceed 200 kA.
7. I<sub>n</sub> Rating: 20 kA.

D. Options:

1. Include LED indicator lights for power and protection status.
2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include NEMA ICS 5, dry Form C contacts rated at 2 A and 24 V(ac) for remote monitoring of protection status.
4. Include surge counter.

### 2.3 CONDUCTORS AND CABLES

- A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Provide OCPD and disconnect for installation of SPD in accordance with UL 1449 and manufacturer's instructions.
- B. Install leads between disconnects and SPDs short, straight, twisted, and in accordance with manufacturer's instructions. Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
1. Do not splice and extend SPD leads unless specifically permitted by manufacturer.
  2. Do not exceed manufacturer's recommended lead length.
  3. Do not bond neutral and ground.
- C. Use crimped connectors and splices only. Wire nuts are unacceptable.

### 3.2 FIELD QUALITY CONTROL

- A. Field tests and inspections must be witnessed by authorities having jurisdiction.
- B. Tests and Inspections:
1. Compare equipment nameplate data for compliance with Drawings and the Specifications.
  2. Inspect anchorage, alignment, grounding, and clearances.
  3. Verify that electrical wiring installation complies with manufacturer's installation requirements.
- C. Nonconforming Work:
1. SPDs that do not pass tests and inspections will be considered defective.
  2. Remove and replace defective units and retest.
- D. Prepare test and inspection reports.
- E. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections as required.

### 3.3 STARTUP SERVICE

- A. Complete startup checks in accordance with manufacturer's instructions.
- B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.
- C. Energize SPDs after power system has been energized, stabilized, and tested.

END OF SECTION

## SECTION 265000

### LIGHTING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.

##### 1.3 SUMMARY

###### A. Section Includes:

1. Interior Lighting
2. Exterior Lighting
3. Classified (Hazardous) Location Lighting.
4. Exit Signs
5. Emergency Lighting
6. Emergency Battery Ballasts & Drivers
7. Luminaire Emergency Transfer Device
8. Poles and Accessories for Support of Luminaires
9. Luminaire Lowering Devices
10. Materials
11. Finishes
12. Luminaire-Mounted Photoelectric Relays.
13. Luminaire Support Components
14. Refurbishing/Restoration of Existing Lighting Fixtures
15. Foundations for Site Lighting Poles and Fixtures

###### B. Related Requirements:

1. Section 260923 "Lighting Controls" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

##### 1.4 DEFINITIONS

- A. BF: Ballast factor
- B. BUG Rating: Backlight, Uplight and Glare rating. Typically applied to outdoor lighting.
- C. CCT: Correlated Color Temperature. The absolute temperature, measured in degrees Kelvin, of a blackbody whose chromaticity most nearly resembles that of the light source.

- D. CRI: Color Rendering Index. Measure of the degree of color shift that objects undergo when illuminated by the light source as compared with the color of those same objects when illuminated by a reference source.
  - E. CU: Coefficient of Utilization. The effective efficiency of a given fixture, in a given space geometry, with given surface reflectance values.
  - F. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
  - G. EPA: Equivalent projected area.
  - H. Fixture: See "Luminaire."
  - I. IP: International Protection or Ingress Protection Rating.
  - J. Lamp: The term used to refer to the complete light source package, such as a fluorescent lamp or an LED light engine.
  - K. LED: Light-emitting diode.
  - L. LER: Luminaire efficacy rating.
  - M. Lumen: Measured output of lamp and luminaire, or both.
  - N. Luminaire: Complete lighting fixture, including lamp/light source; lamp sockets or mounting equipment; housing; ballast/driver (if required); diffusers/refractors or light control medium; and other appurtenances required for a complete, fully functional installation.
  - O. MacAdam Ellipse: A region on a chromaticity diagram which contains all colors which are indistinguishable, to the average human eye, from the color at the center of the ellipse.
  - P. Pole: Luminaire-supporting structure, including towers used for large-area illumination.
  - Q. RCR: Room cavity ratio. A single numerical value summarizing the complete space geometry including length, width, and height.
  - R. SSL: Solid State Lighting, which refers to a type of lighting that uses semiconductor light-emitting diodes (LEDs), organic light-emitting diodes (OLED), or polymer light-emitting diodes (PLED) as sources of illumination rather than electrical filaments, plasma (used in arc lamps such as fluorescent lamps), or gas.
  - S. Standard: See "Pole."
- 1.5 ACTION SUBMITTALS
- A. Product Data: For each type of product.
    1. Arrange in order of luminaire designation.
    2. Include data on features, accessories, and finishes.
    3. Include physical description and dimensions of luminaires.
    4. Include emergency lighting units, including batteries and chargers.
    5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.

6. Printed photometric data and adjustment factors based on laboratory tests including photometric data which includes luminaire efficiency and Coefficient of Utilization table for the specific luminaire configuration specified, complying with IES "Lighting Measurements Testing and Calculation Guides" for each luminaire type. Photometric data shall be provided in printed form. Inclusion of the .ies file only is not acceptable.

- a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings – Building Interior: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Luminaires.
2. Suspended ceiling components.
3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
4. Structural members to which equipment and/or luminaires will be attached.
5. Initial access modules for acoustical tile, including size and locations.
6. Items penetrating finished ceiling, including the following:
  - a. Other luminaires.
  - b. Air outlets and inlets.
  - c. Speakers.
  - d. Sprinklers.
  - e. Access panels.
  - f. Ceiling-mounted projectors.
7. Moldings or other architectural features.

B. Coordination Drawings – Site Lighting: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Luminaires.
2. Structural members to which equipment and luminaires will be attached.
3. Underground utilities and structures.
4. Existing underground utilities and structures.
5. Above-grade utilities and structures.
6. Existing above-grade utilities and structures.
7. Building features.
8. Vertical and horizontal information.

C. Material Test Reports:

1. For each foundation component, by a qualified testing agency.
2. For each pole, by a qualified testing agency.

D. Sample Warranty: Manufacturer's standard warranty.

#### 1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

#### 1.8 SUBSTITUTIONS

A. The lighting design is based on the fixture type and manufacturers specified and only the fixture indicated by catalog number has been approved. Should a substitute fixture be proposed for one or more of those specified, the Design Professional may request a working sample of one or more of the proposed substitutions, as well as a sample of the comparable fixture to allow side by side comparison. Where substitutions are requested, they shall be provided promptly to the Design Professional's office, along with complete photometric data, prepared and certified by an independent lighting fixture testing laboratory for both the specified and proposed substitute fixtures. Fixture samples shall be full working samples, complete with lamps, cord & NEMA 5-15P plug, 120 volt ballast or driver and any controls required to demonstrate the full luminaire operating performance.

B. The substituted fixture(s) shall be equal or better in quality to that specified and will be evaluated by the Design Professional based on the following comparisons:

1. Appearance
2. Performance:
  - a. Light Distribution (independent testing laboratory certified photometrics, etc.)
  - b. Luminaire Efficiency Rating
  - c. Coefficient of Utilization
  - d. Spacing to Mounting Height Ratio (parallel and perpendicular)
3. Construction
  - a. Similar materials
  - b. Quality and Gauge of Materials
  - c. Finishes
  - d. Workmanship
  - e. Rigidity
  - f. Installation Ease
4. Maintainability:
  - a. Hinging and Latching
  - b. Cleaning and Relamping
  - c. Ballast/Driver replacement

C. Whenever Solid State Lighting (SSL) type fixtures are proposed to be substituted for those specified, and for any other fixture substitutions as requested by the Design Professional during the review process, provide point by point lighting calculations for each room or area to allow more specific review of the actual fixture performance in actual project situations. Point by point calculations shall be provided for both the specified and proposed substitute light fixtures, with illumination at points on a 1' x 1' grid for interior spaces and a 5' x 5' grid for exterior areas. Point by point calculations shall



provide performance summaries for each area to be illuminated. The calculation boundaries shall be set to calculate only the actual area to be illuminated, with adjacent areas not included in the calculations or performance summaries. The performance summary shall include the following data:

1. Average illumination (footcandles)
2. Minimum illumination (footcandles)
3. Maximum illumination (footcandles)
4. Maximum to minimum illumination ratio
5. Average to minimum illumination ratio
6. Total lighting system input watts
7. Light Loss Factor (LLF) used
8. Fixture Coefficient of Utilization (C.U.)

#### 1.9 QUALITY ASSURANCE

##### A. Luminaire Photometric Data Testing Laboratory Qualifications:

1. Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

##### B. Each LED luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

#### 1.10 DELIVERY, STORAGE, AND HANDLING – SITE LIGHTING POLES

##### A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

##### B. Package aluminum poles for shipping according to ASTM B660.

##### C. Store poles on decay-resistant skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

#### 1.11 WARRANTY

##### A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires which fail in materials or workmanship within the project warranty period specified in Section 260000 and Division 1 sections.

##### B. Special Warranties. Manufacturer and Installer agree to repair or replace the following components which fail in materials or workmanship within the periods specified below:

###### 1. Special Extended Warranty for Ballasts and Drivers:

- a. Manufacturer's standard form in which ballast/driver manufacturer agrees to repair or replace ballasts or drivers which fail in materials or workmanship within specified warranty period:

- 1) Special Warranty Period for LED Drivers: Five (5) years from date of project Substantial Completion.

###### 2. Special Warranty for Exterior Luminaires and Poles:

- a. Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
  - 1) Warranty Period for Luminaires, Poles, and accessories: Repair or replace exterior luminaires, poles and standards and accessories that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than five (5) years from date of project Substantial Completion.
3. Special Extended Warranty on Luminaire Emergency Transfer Devices:
  - a. Manufacturer's standard form in which Luminaire Emergency Transfer Device manufacturer agrees to repair or replace devices which fail in materials or workmanship within five (5) years from date of project Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS:

- A. Refer to Lighting Fixture Schedule on the drawings for complete list of luminaire types, descriptions, lamping, and manufacturers.
- B. Provide luminaires from a single manufacturer for each luminaire type.

### 2.2 LUMINAIRE REQUIREMENTS:

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, "National Electrical Code," by a qualified testing agency, and marked for intended location and application.
- B. Factory-Applied Labels: Comply with UL 1598, "Luminaires." Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
  1. Label shall include the following lamp characteristics:
    - a. "USE ONLY" and include specific lamp type.
    - b. Lamp diameter, shape, size, wattage, and coating.
    - c. CCT and CRI.
- C. Recessed luminaires shall comply with NEMA LE 4, "Recessed Luminaires, Ceiling Compatibility."
  1. Where lighting fixtures are indicated to be recessed mounted, coordinate with the actual ceiling type into which the fixture is to be installed. Furnish and install all required mounting accessories, installation kits, fixture modifications etc. as may be required to install the fixture in the ceiling type as indicated on the Architectural Reflected Ceiling Plan. Exact ceiling finishes and types shall be coordinated with the Architectural Drawings. The indication of a ceiling grid system on the electrical drawings shall not relieve the Contractor of their obligation to verify ceiling construction.

2. Where recessed lighting fixtures are to be mounted in a fire rated ceiling, a fire protective enclosure shall be provided around the fixture assembly in order to maintain the fire rated integrity of the ceiling. The fire rated enclosure shall be provided under the Electrical Divisions and shall be installed by a qualified Acoustical Ceiling Contractor. The fire rated enclosure shall be installed in full accordance with all manufacturers recommendations. Fixtures provided with such protection shall be UL listed for installation in contact with insulating materials and shall be provided with suitable thermal protection. Coordinate with the Architectural drawings to determine where, if any, such protection may be required. Fixtures which are UL listed as being of the same fire resistive rating as the ceiling will not be required to have such enclosures, provided that the UL listing is certified and included with the Lighting Fixture Submittals.

D. UL Compliance: Comply with UL 1598, "Luminaires."

E. Lamp base complying with ANSI C81.61, "American National Standard for Electrical Lamp Bases."

F. Except as specifically indicated otherwise, luminaires utilizing ballasts or drivers shall have auto-sensing ballast/driver suitable for use on Nominal Operating Voltage from 120 through 277 volts.

### 2.3 PERFORMANCE REQUIREMENTS – EXTERIOR LIGHTING:

A. Site Lighting Poles:

1. Structural Characteristics: Comply with AASHTO LTS-6-M, "Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals."
2. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied according to AASHTO LTS-6-M.
3. Live Load: Single load of 500 lbf distributed according to AASHTO LTS-6-M.
4. Ice Load: Load of 3 lbf/sq. ft., applied according to AASHTO LTS-6-M for applicable areas on the Ice Load Map.

B. Wind Load: Pressure of wind on pole and luminaire, calculated and applied according to AASHTO LTS-6-M.

1. Basic wind speed for calculating wind load for poles 50 feet high or less is 90 mph.
  - a. Wind Importance Factor: 1.0.
  - b. Minimum Design Life: 25 years.
  - c. Velocity Conversion Factor: 1.0.

C. Strength Analysis: For each pole, multiply the actual EPA of luminaires and brackets by a factor of 1.1 to obtain the EPA to be used in pole selection strength analysis.

D. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

### 2.4 LED REPLACEMENT LAMPS:

A. Provide integral driver LED lamps for luminaires which are provided with standard lamp sockets, or for relamping of all existing fixtures indicated to remain.

B. LED Lamps shall match shape, size, appearance, beam spread, voltage and lumen rating of the lamp on which the luminaire is based. Lamp base shall exactly match that of the luminaire into which it is to be installed.

- C. Unless a higher rating is indicated in the Lighting Fixture Schedule, the LED lamps shall have a minimum Color Rendering Index (CRI) of 80. Lamp shall be of the Correlated Color Temperature (CCT) indicated in the Lighting Fixture Schedule.
- D. All LED lamps shall be suitable for dimming down to a minimum of 10% full light output.
- E. LED Lamps for indoor or protected outdoor use shall be UL listed as suitable for damp locations. Lamps for outdoor, or for high humidity indoor spaces, shall be UL listed as suitable for wet locations. All LED lamps shall be Energy Start Certified.
- F. Provide a complete list of all LED Replacement Lamps to be utilized for the project, along with manufacturer data sheet for each lamp type.

## 2.5 DRIVERS:

### A. General:

1. Provide proper drivers for all fixtures employing lamps which require ballasts, drivers, transformers, or other lamp power supply devices.
2. LED drivers and fluorescent ballasts shall operate from a 120 through 277 volt (auto selecting), 60 hertz input source with sustained variations of +/- 10% (voltage and frequency) with no damage to the driver or ballast.
3. All ballasts and drivers shall be UL component recognized.
4. All ballasts and drivers shall be certified Polychlorinated Biphenyl (PCB) free.
5. Electronic drivers, where specified hereinafter, shall meet the requirements of the Federal Communications Commission rules and regulations, Title 47 CFR part 18, for Non-Consumer equipment.

### B. Light Emitting Diode (LED) Drivers:

1. Light Emitting Diode (LED) Driver shall be mounted in an all metal housing suitable for use in air handling plenums.
2. LED driver output shall be regulated to +/- 5% across published load range.
3. LED driver shall operate LED's at their rated input voltage of 12 volts, 24 volts or DC where Luxeon LED's are provided.
4. LED driver shall have a Power Factor greater than 0.90 for primary application.
5. LED Driver input current shall have Total Harmonic Distortion (THD) of less than 20%.
6. LED Driver shall have a Class A sound rating.
7. LED Driver shall have a minimum operating temperature of -40C (-40F).
8. LED Driver shall tolerate sustained open circuit and short circuit output conditions without damage and without need for external fuses or trip devices.
9. LED driver shall not contain any Polychlorinated Biphenyl (PCB).
10. LED driver shall be Underwriters Laboratories (UL) listed, Class 2 Outdoor.
11. LED driver shall comply with ANSI C62.41 Category A for Transient protection.
12. LED driver shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 15, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
13. LED drivers shall be warrantied for a period of five-years from date of project substantial completion against defects in material or workmanship, including replacement, for operation at a maximum case temperature of 90C.
14. LED driver shall be Philips Advance Transformer Xitanium™ or approved equal.
15. Dimming:
  - a. All LED drivers shall provide for dimming, at a minimum from 10% to 100% of light output, unless a wider dimming range is specified in the Lighting Fixture Schedule. Unless otherwise indicated, dimming protocol shall be 0-10 VDC. Coordinate specific dimming protocol requirements with Automated Lighting Controls.

- b. Provide a complete system of fixtures, LED's, electronic dimming LED drivers and dimming controls which are certified by the manufacturers of each component for use together as a complete, fully functional system.

## 2.6 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING:

- A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, "National Electrical Code" and UL 924, "Standard for Emergency Lighting and Power Equipment" by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
- B. Comply with NFPA 101, "Life Safety Code."
- C. Comply with NEMA LE 4, "Recessed Luminaires, Ceiling Compatibility" for recessed luminaires.
- D. Comply with UL 1598, "Luminaires."

## 2.7 EMERGENCY BATTERY UNITS:

- A. Provide self-contained Emergency Battery Units to provide emergency lighting in case of utility power failure and/or generator failure in the main electric room or where indicated on the drawings.
- B. Battery shall be sealed, maintenance-free, lead-acid type.
- C. Battery charger shall be fully automatic, solid-state type with sealed transfer relay.
- D. Light source shall be white LED.
- E. Operation: The transfer relay shall automatically turn lamps on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Battery shall provide operation of integral lamps, plus any attached remote heads, for a minimum of 90 minutes. Lamps shall be automatically disconnected from battery when voltage approaches deep-discharge level. When normal power supply circuit voltage is restored, the relay shall automatically disconnect the lamps from battery, and the battery shall be automatically recharged. The battery shall be maintained at full charge by automatic float charge operation.
- F. Provide a Push-To-Test switch, in unit housing, which shall simulate the loss of normal power and demonstrate unit operability.
- G. Provide an LED Indicator Light to indicate normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
- H. Integral Self-Test:
  - 1. Emergency Battery Units shall include an Integral Self-Test feature which shall automatically initiate a code-required test of unit emergency operation at required intervals. Failure of the unit shall be annunciated by an integral audible alarm and flashing red LED.

## 2.8 EXIT SIGNS:

- A. General Characteristics: Comply with UL 924, "Standard for Emergency Lighting and Power Equipment;" for sign colors, visibility, luminance, and lettering size, comply with local Authorities Having Jurisdiction requirements.

- B. Provide exit signs as indicated on the drawings, to indicate exit/egress pathways throughout the building. Exit signs shall comply with UL Standard 924, "Standard for Emergency Lighting and Power Equipment," with NFPA-101, "Life Safety Code," and with requirements of the local Authority Having Jurisdiction (AHJ) for sign colors, visibility, luminance, and lettering size. Confirm color of exit sign with local Authority Having Jurisdiction prior to ordering of exit signs.
- C. Exit signs shall bear the United States Environmental Protection Agency (EPA) Energy Star Label.
- D. Lamps shall be LEDs with 70,000 hours minimum rated lamp life.

#### 2.9 LED EMERGENCY BATTERY DRIVER UNITS:

- A. Where indicated in the Lighting Fixture Schedule on the drawings, provide LED Emergency Battery Driver Units to serve LED lighting fixtures for emergency lighting purposes. The fixture to which the LED Emergency Battery Driver Unit shall operate at 100% output when operating on battery power for a minimum of 90 minutes.
- B. Provide self-contained, modular, battery-inverter unit. Units for LED fixtures shall be external type, remote mounted from lighting fixture, in an enclosure UL listed for installation in air handling plenum spaces.
- C. Comply with UL Standard 924, "Standard for Emergency Lighting and Power Equipment."
- D. Emergency Connection: The LED Emergency Battery Driver Unit shall operate the entire fixture at its normal rated lumen output. Connect unswitched circuit to LED Emergency Battery Driver Unit and switched circuit to fixture driver.
- E. The LED Emergency Battery Driver Unit shall include a remote Test Push Button and Indicator Light which shall be visible and accessible without opening fixture or entering ceiling space.
  - 1. Push Button shall be push-to-test type, mounted in the ceiling adjacent to the fixture. The Test Push Button shall simulate loss of normal power and demonstrate unit operability.
  - 2. Indicator Light shall be an LED which indicates normal power on. Normal glow shall indicate trickle charge; bright glow shall indicate charging at end of discharge cycle.
- F. Battery shall be sealed, high temperature, maintenance-free, nickel-cadmium type.
- G. Charger shall be fully automatic, solid-state, constant-current type with sealed power transfer relay.
- H. LED Emergency Battery Driver Units shall be Philips Bodine series BSL, which shall form the basis of design. Subject to compliance with all contract requirements, substitutions may be considered from Dual-Lite, Iota or Lithonia.

#### 2.10 LUMINAIRE EMERGENCY TRANSFER DEVICE (LETD):

- A. Provide a Luminaire Emergency Transfer Device unit at each fixture indicated for emergency power operation. It shall be mounted either within the fixture ballast channel, as for troffer style fixtures, or exposed in accessible ceiling space adjacent to the fixture for downlights, wall sconces and similar fixtures. The unit housing shall be steel, NEMA 1 rated for dry or damp locations, and UL listed as suitable for installation in air handling plenum spaces.

- B. The Luminaire Emergency Transfer Device shall either bypass the lighting control, or where 0-10 volt control is provided, shall automatically drive the control to provide 100% light output when operating on emergency power.
- C. The unit shall be listed by Underwriters Laboratories in accordance with standard UL 924, "Emergency
- D. Lighting and Power Equipment." It shall be listed for factory or field installation.
- E. The Luminaire Emergency Transfer Device shall be fully warranted, against defects in materials and workmanship, for a period of five (5) years from the date of project Substantial Completion.
- F. Luminaire Emergency Transfer Device shall be Philips Bodine GTD10DIM, which shall form the Basis of Design. Subject to compliance with all contract requirements, substitutions may be considered from Dual-Lite or the fixture manufacturer.

#### 2.11 ALUMINUM POLES:

- A. Poles: Seamless, extruded structural tube complying with ASTM B221, Alloy 6063-T6, with access handhole in pole wall.
  - 1. Shape: Square, straight.
  - 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- B. Mast Arms: Aluminum type, continuously welded to pole attachment plate. Material and finish same as plate.
- C. Brackets for Luminaires: Detachable, cantilever, without underbrace.
  - 1. Adaptor fitting welded to pole, allowing the bracket to be bolted to the pole-mounted adaptor, then bolted together with [stainless] [galvanized]-steel bolts.
  - 2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire. Match pole material and finish.
- D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- E. Grounding and Bonding Lugs: Bolted 1/2-inch threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- F. Fasteners: Galvanized steel, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.
  - 1. Materials: Compatible with poles and standards as well as to substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.
  - 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
- G. Handhole: Oval shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.
- H. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
  2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
  3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I clear coating of 0.018 mm or thicker), complying with AAMA 611.
- I. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
  2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
  3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
    - a. Color: As selected by Architect from manufacturer's full range.
- J. Powder-Coat Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
  2. Powder coat shall comply with AAMA 2604.
    - a. Electrostatic applied powder coating; single application with a minimum 2.5- to 3.5-mils dry film thickness; cured according to manufacturer's instructions. Coat interior and exterior of pole for equal corrosion protection.
    - b. Color: As selected by Architect from manufacturer's full range.

## 2.12 MOUNTING HARDWARE:

- A. Anchor Bolts: Manufactured with a minimum yield strength of 55,000 psi.
1. Galvanizing: Hot dip galvanized according to ASTM A153, Class C.
  2. Bent rods minimum 3/4 inches diameter by minimum 24 inches in length, unless larger recommended by pole manufacturer.
  3. Threading: Uniform National Coarse.
- B. Nuts: ASTM A563, Grade A, Heavy-Hex.
1. Galvanizing: Hot dip galvanized according to ASTM A153, Class C.
  2. Two nuts provided per anchor bolt, shipped with nuts pre-assembled to the anchor bolts.
- C. Washers: ASTM F436, Type 1.
1. Galvanizing: Hot dip galvanized according to ASTM A153, Class C.
  2. Two washer(s) provided per anchor bolt.



## 2.13 MATERIALS

### A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

### B. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for sheet steel.

### C. Stainless Steel:

1. Manufacturer's standard grade.

### D. Galvanized Steel: ASTM A653/A653M.

### E. Aluminum: ASTM B209.

### F. Doors, Frames, and Other Internal Access:

1. Smooth operating, free of light leakage under operating conditions.
2. Designed to permit relamping without use of tools.
3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

### G. Lenses, Diffusers, and Globes:

1. Glass: Clear glass shall be annealed crystal glass unless otherwise indicated.
2. Fresnel Glass: Tempered
3. Acrylic Lighting Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
4. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

### H. Factory-Applied Labels: For luminaires with field replaceable lamps, comply with UL 1598, "Luminaires." Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:
  - a. "USE ONLY" and include specific lamp type.
  - b. Lamp diameter, shape, size, wattage, and coating.
  - c. CCT and CRI for all luminaires.

## 2.14 GENERAL FINISH REQUIREMENTS

### A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

### B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## 2.15 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

## 2.16 FINISHES – EXTERIOR LIGHTING

- A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

- B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping.

- 1. Where indicated, match finish process and color of pole or support materials.
- 2. Where indicated, provide custom color based on sample provided or Based on manufacturer color number.

- C. Factory-Applied Finish for Aluminum luminaires: Comply with National Association of Architectural Metal Manufacturers (NAAMM) "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

- 1. Finish shall be as indicated in the Lighting Fixture Schedule on the drawings, as follows:

- a. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- b. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
- c. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
- d. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.
- e. Color: As indicated in the Lighting Fixture Schedule.

- D. Factory-Applied Finish for Steel luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

- 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
- 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

- a. Color: As indicated in the Lighting Fixture Schedule.

## 2.17 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

- A. Comply with UL 773, "Standard for Plug-In Locking Type Photocontrols for Use with Area Lighting."

- B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.
  - 1. Relay with locking-type receptacle shall comply with ANSI C136.10.
  - 2. Adjustable window slide for adjusting on-off set points.

#### 2.18 LUMINAIRE SUPPORT COMPONENTS:

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Wires for Humid Spaces: ASTM A580/A580M, Composition 302 or 304, annealed stainless steel, 12 gage.
- E. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- F. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

#### 2.19 POWER-INSTALLED SCREW FOUNDATIONS FOR SITE LIGHTING POLES AND FIXTURES:

- A. At the Contractor's Option, foundations for pole mounted luminaires may be Power Installed Screw Foundations.
- B. Power Installed Screw Foundations shall be a factory fabricated assembly, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.
- C. Baseplate: Stamped with manufacturer's name, date of production, and cable entry.
- D. Submit data to indicate applicability of pole foundation to poles intended for project.
- E. Power installed screw foundations shall be self augering steel bases as manufactured by A.B. Chance, a Division of Hubbell Power Systems, Inc., or approved equal. Install foundations in strict accordance with all manufacturers recommendations.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION:

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

- C. Examine walls, roofs, canopies and overhangs for suitable conditions where luminaires will be installed.
  - D. Proceed with installation only after unsatisfactory conditions have been corrected.
- 3.2 TEMPORARY LIGHTING:
- A. If approved by the Design Professional, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting.
- 3.3 INSTALLATION:
- A. Comply with NECA 1, Standard For Good Workmanship In Electrical Construction.
  - B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
  - C. Install lamps/light source in each luminaire, as recommended by the luminaire manufacturer.
  - D. Supports:
    - 1. In no case shall the weight of the luminaire or any component thereof be supported by ceiling tiles.
    - 2. Sized and rated for luminaire and all associated components weight.
    - 3. Able to maintain luminaire position after cleaning and relamping.
    - 4. Provide support for luminaire without causing deflection of ceiling or wall.
    - 5. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
  - E. Luminaires Mounted in Suspended Grid Type Ceilings:
    - 1. Secure to any required outlet box.
    - 2. Secure luminaire to the ceiling grid using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
    - 3. Use approved devices and support components (ceiling hanger wires, etc.) to connect ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.
  - F. Flush-Mounted Luminaires:
    - 1. Secured to outlet box.
    - 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
    - 3. Trim ring flush with finished surface.
  - G. Wall-Mounted Luminaires:
    - 1. Attached to structural members where located in appropriate position, or to a minimum 20 gauge backing plate attached to wall structural members where wall structural members are not located where needed.
    - 2. Do not attach luminaires directly to gypsum board.
  - H. Suspended Luminaires:
    - 1. Ceiling Mount, by one of the following methods as indicated in the Lighting Fixture Schedule:

- a. Minimum of two 5/32-inch diameter aircraft cable supports, adjustable in length.
    - b. Pendant mount, with field adjustable pendant tubes or rods.
    - c. Hook mount.
  - 2. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
  - 3. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
  - 4. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing, rod or aircraft cable support for suspension for each unit length of luminaire chassis, including one at each end.
  - 5. Do not use ceiling grid as support for suspended luminaires. Connect support wires or rods to building structure.
- I. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.
- 3.4 INSTALLATION – EXTERIOR LUMINAIRES:
- A. Wiring Method: Install cables in raceways. Conceal raceways and cables.
  - B. Install luminaires level, plumb, and square with finished grade unless otherwise indicated.
  - C. Install floodlight type luminaires at height and aiming angle as indicated on drawings.
  - D. Coordinate layout and installation of luminaires with other construction.
  - E. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.
  - F. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533.13 "Conduits for Electrical Systems" and 260533.16 "Boxes and Covers for Electrical Systems" for wiring connections and wiring methods.
- 3.5 INSTALLATION OF BOLLARD LUMINAIRES:
- A. Align units for optimum directional alignment of light distribution.
    - 1. Install on concrete base with top 4 inches above finished grade or flush with adjacent paved surface at luminaire location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth.
- 3.6 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES:
- A. Aim as indicated on Drawings.
  - B. Install on concrete base with top 4 inches above finished grade or flush with adjacent paved surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."
- 3.7 POLE FOUNDATIONS:
- A. Cast-in-Place Concrete Pole Foundations:

1. Provide cast in place reinforced concrete foundations for all site lighting poles, bollards, floodlights and other fixtures which are not mounted on buildings or other structural elements.
2. Anchor Bolts: Provide anchor bolts to match pole-base flange. Install plumb using manufacturer-supplied template, uniformly spaced.
3. Concrete foundations shall extend a minimum of 1/6 of the pole height below grade, but in no case shall the bottom of the excavation be less than 4 feet below grade.
4. Foundations for poles within 5 feet of driveways, parking lots, and other traffic areas shall extend a minimum of 24" above finished grade. Foundations for other poles and fixtures shall be set flush with grade unless otherwise noted.
5. For poles taller than 25', or for poles taller than 10' in sandy or unstable soil, engage the services of a Registered Professional Structural Engineer to design the pole foundation. Submit drawing, signed and sealed by the Structural Engineer, for concrete foundation design prior to beginning installation.
6. Provide 3/4" diameter x 10'-0" long copper clad steel ground rod at each site lighting pole. Bond ground rod to pole grounding lug and to circuit ground conductors within pole. Connection to ground rod shall be via exothermic weld connection.
7. Once concrete has set, remove all above grade formwork. Rub exposed portions of base smooth and parge with skim coat of finish concrete.

B. Pre-Cast Foundations:

1. Factory fabricated, with structural steel complying with ASTM A36/A36M and hot-dip galvanized according to ASTM A123/A123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories.

C. Power-Installed Screw Foundations:

1. Foundations for poles shall be set flush with grade unless otherwise noted or specified below.
2. Foundations for poles within 5 feet of driveways, parking lots, and other traffic areas, or where indicated on the drawings to be a raised foundation, shall extend a minimum of 24" above finished grade. Halt penetration of the foundation at the proper depth to achieve the base height desired. After feeding the power conduit through the cableway and out the baseplate, install a tube-type form and encase the exposed section of the power installed screw foundation shaft in poured-concrete from a minimum of 24" below grade to the height noted above grade.

3.8 POLE INSTALLATION:

- A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on drawing.
  1. Fire Hydrants and Water Piping: 60 inches.
  2. Water, Gas, Electric, Communications, and Sewer Lines: 5 feet.
  3. Trees: 15 feet from tree trunk.
- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer.
- D. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level according to pole manufacturer's written instructions.

1. Grout void between pole base and foundation. Use non-shrink or expanding concrete grout firmly packed to fill space.
2. Install base covers unless otherwise indicated.
3. Use a short piece of 1/2 -inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Raise and set pole using web fabric slings (not chain or cable) at locations indicated by manufacturer.

### 3.9 GROUNDING:

A. Ground Metal Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground Nonmetallic Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.
3. Ground metallic components of pole accessories and foundation.

### 3.10 CORROSION PREVENTION:

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum using insulating fittings or treatment.

B. Steel Conduits: Comply with requirements in Section 260533.13 "Conduits for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50-percent overlap.

### 3.11 IDENTIFICATION:

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.12 FIELD QUALITY CONTROL:

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Illumination Tests – Exterior Lighting:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):
  - a. IES LM-64, "Photometric Measurements Of Parking Areas."
  - b. IES LM-72, "Directional Positioning Of Photometric Data."

2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
- C. Luminaire will be considered defective if it does not pass operation tests and inspections.
  - D. Prepare test and inspection reports.
  - E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.
  - F. Tests and Inspections:
    1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
  - G. Nonconforming Work:
    1. Luminaire will be considered defective if it does not pass operation tests and inspections.
    2. Remove and replace defective units and retest.
  - H. Prepare Test and Inspection Reports.
  - I. Manufacturer Services:
    1. Engage factory-authorized service representative to support field tests and inspections as required.
- 3.13 ADJUSTING:
- A. Aiming: Where Luminaires include adjustable or aimable light output, adjust or aim the fixtures to provide the best illumination, and to illuminate the intended subject.
  - B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
    1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
    2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
    3. Adjust the aim of luminaires in the presence of the Design Professional.
  - C. Emergency Lighting Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:
    1. Inspect luminaires. Replace lamps, emergency power units, batteries, exit signs, and luminaires that are defective.
      - a. Parts and supplies must be manufacturer's authorized replacement parts and supplies.
    2. Conduct short-duration tests on all emergency lighting.



3.14 SYSTEM STARTUP:

A. Perform startup service:

1. Charge emergency power units and batteries minimum of one hour and depress switch to conduct short-duration test.
2. Charge emergency power units and [batteries minimum of 24 hours and conduct one-hour discharge test.

3.15 DEMONSTRATION

- A. Owner's maintenance personnel to adjust, operate, and maintain luminaires and photocell relays.

3.16 PROTECTION

- A. Remove and replace luminaires and exit signs that are damaged or caused to be unfit for use by construction activities.

3.17 RELAMPING PROVISIONS:

- A. Instruct Owners Representative in proper manner of maintaining and relamping all lighting fixtures.
- B. Provide facilities for relamping of fixtures by the Owner's maintenance personnel. Provide two (2) of all tools or accessories required for fixture access.

3.18 LUMINAIRE AIMING SESSION:

- A. Following completion of the lighting installation, including all controls, dimming systems, etc., provide a Luminaire Aiming Session in conjunction with the Owner Engineer, and Architect. This session shall be of sufficient duration to accurately aim all adjustable lighting fixtures within the project area. The aiming session shall be conducted at dusk or later to avoid impact from natural lighting sources.
- B. Each adjustable lighting fixture shall be individually adjusted to best illuminate the intended area or feature, to the complete satisfaction of the Owner and the Design Professional. Once a fixture has been aimed, it shall be securely locked in that position using locking mechanisms built into the fixture. Mark, with permanent markers on the fixture housing, exact aiming positions to permit fixture to be returned to the identical position following future re-lamping or maintenance.
- C. Provide all required labor, materials, lifts, ladders, equipment, etc. as required to perform the fixture aiming. Provide a properly calibrated digital light meter for taking illumination readings. Provide two-way radio system for communications during the aiming session. Have sufficient stock of spare lamps of each type used in the project on hand to replace burned out or damaged lamps.

END OF SECTION

## SECTION 265213

### EMERGENCY AND EXIT LIGHTING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

###### A. Section Includes:

1. Emergency lighting.
2. Exit signs.
3. Materials.
4. Luminaire support components.

###### B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 260000 "General Requirements for Electrical," apply to this Section.

##### 1.3 DEFINITIONS

- A. Correlated Color Temperature (CCT): The absolute temperature, measured in kelvins, of a blackbody whose chromaticity most nearly resembles that of the light source.
- B. Color Rendering Index (CRI): Measure of the degree of color shift that objects undergo when illuminated by the light source as compared with the color of those same objects when illuminated by a reference source.
- C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
- D. Lumen (lm): The SI derived unit of luminous flux equal to the luminous flux emitted within a unit solid angle by a unit point source (1 lm = 1 cd-sr).

##### 1.4 ACTION SUBMITTALS

###### A. Product Data:

1. For each type of emergency lighting unit, exit sign, and emergency lighting support.
  - a. Include data on features, accessories, and finishes.
  - b. Include physical description of unit and dimensions.
  - c. Battery and charger for light units.
  - d. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.

- e. Include photometric data and adjustment factors based on laboratory tests by, or under supervision of, qualified luminaire photometric testing laboratory, for each luminaire type.
  - B. Shop Drawings:
    - 1. For nonstandard or custom luminaires.
      - a. Include plans, elevations, sections, and mounting and attachment details.
      - b. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      - c. Include diagrams for power, signal, and control wiring.
  - C. Product Schedule:
    - 1. For emergency lighting units.
    - 2. For exit signs.
- 1.5 INFORMATIONAL SUBMITTALS
- A. Product Certificates: For each type of luminaire.
  - B. Product Test Reports: For each luminaire for tests performed by, or under supervision of, qualified luminaire photometric testing laboratory.
- 1.6 QUALITY ASSURANCE
- A. FM Global Compliance: Luminaires for hazardous locations must be listed and labeled for indicated class and division of hazard by FM Global.
- 1.7 DELIVERY, STORAGE, AND HANDLING
- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

- A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70 and UL 924, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
- B. Comply with NFPA 101.
- C. Comply with NEMA LE 4 for recessed luminaires.
- D. Comply with UL 1598 for fluorescent luminaires.

### 2.2 EMERGENCY LIGHTING

- A. General Characteristics: Self-contained units.
- B. Emergency Luminaire:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Cooper Lighting Solutions; Signify North America Corp.
  - b. Lithonia Lighting; Acuity Brands Lighting, Inc.
  - c. Philips; Signify North America; Signify Holding.
2. Options:
  - a. Operating at nominal voltage of 277 V(ac).
  - b. Internal emergency power unit.
  - c. Rated for installation in damp locations, and for sealed and gasketed luminaires in wet locations.
  - d. UL 94 flame rating.

### 2.3 EXIT SIGNS

- A. General Characteristics: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Sign:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Cooper Lighting Solutions; Signify North America Corp.
    - b. Lithonia Lighting; Acuity Brands Lighting, Inc.
    - c. Philips; Signify North America; Signify Holding.
  2. Options:
    - a. Operating at nominal voltage of 277 V(ac).
    - b. Lamps for AC Operation:
      - 1) LEDs; 50,000 hours minimum rated lamp life.
    - c. Master/Remote Sign Configurations:
      - 1) Master Unit: Comply with requirements above for self-powered exit signs and provide additional capacity in LED power supply for power connection to remote unit.
      - 2) Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

### 2.4 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Support Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 0.106 inch.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- B. Supports:
  - 1. Sized and rated for luminaire weight.
  - 2. Able to maintain luminaire position when testing emergency power unit.
  - 3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
  - 4. Luminaire-mounting devices must be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.
- C. Wall-Mounted Luminaire Support:
  - 1. Attached to structural members in walls.
  - 2. Do not attach luminaires directly to gypsum board.
- D. Suspended Luminaire Support:
  - 1. Pendants and Rods: Where longer than 48 inch, brace to limit swinging.
  - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
  - 3. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- E. Ceiling Grid Mounted Luminaires:
  - 1. Secure to outlet box, if provided.
  - 2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
  - 3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

### 3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.4 FIELD QUALITY CONTROL

- A. Field tests and inspections must be witnessed by authorities having jurisdiction.
- B. Tests and Inspections:
  - 1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- C. Nonconforming Work:
  - 1. Luminaire will be considered defective if it does not pass operation tests and inspections.
  - 2. Remove and replace defective units and retest.
- D. Prepare test and inspection reports.
- E. Manufacturer Services:
  - 1. Engage factory-authorized service representative to support field tests and inspections as required.

### 3.5 ADJUSTING

- A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:
  - 1. Inspect luminaires. Replace exit signs and luminaires that are defective.
    - a. Parts and supplies must be manufacturer's authorized replacement parts and supplies.
  - 2. Conduct short-duration tests on all emergency lighting.

### 3.6 PROTECTION

- A. Remove and replace luminaires and exit signs that are damaged or caused to be unfit for use by construction activities.

END OF SECTION

## SECTION 270000

### GENERAL REQUIREMENTS FOR TELECOMMUNICATIONS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS:

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.
- B. This Section shall apply to all Divisions 26, 27, and 28 Sections of these specifications as hereinafter written.
- C. Instructions to Bidders, Bidding Forms, Forms of Agreement between Owner and Contractor, Contract Award Date, Starting and Completion Dates, Conditions of the Contract, Insurance Requirements, and other Owner Requirements will be furnished separately by the Owner. These documents, as well as any addenda issued, shall form a part of these Specifications, and this contractor shall consult them in detail for instructions pertaining to this work.
- D. Each trade contractor shall receive all drawings and specification sections issued as part of the overall bid package. All contractors are to receive, review, and coordinate all of their work as shown or referenced on the other trade documents. All work shown or referenced on the other trade documents shall be included as part of the overall project scope for that particular discipline and trade.

##### 1.2 SCOPE OF WORK:

- A. These specifications and accompanying drawings are intended to cover the furnishing of all labor, material, and equipment and superintendence of the Telecommunications System.
- B. It is the intent and purpose of these specifications and accompanying drawings to cover and include each item, all materials, machinery, apparatus, and labor necessary to properly install, equip, adjust, and put into perfect operation the respective portions of the installations specified and to so interconnect the various items or sections of the work as to form a complete and properly operating whole.
- C. Any equipment, apparatus, machinery, material, and small items not mentioned in detail, and labor not hereinafter specifically mentioned, which may be found necessary to complete or perfect any portion of installation in a substantial manner, and in compliance with the requirements stated, implied, or intended in these specifications shall be furnished without extra cost. This shall include all materials, devices, or methods peculiar to the machinery, equipment, apparatus, or systems furnished and installed as part of the Telecommunications work.
- D. The term "Furnish" shall mean to obtain and supply to the job site. The term "Install" shall generally mean to fix in position and connect for use. Where language indicates that one party or trade is to "install", and another is to "connect", the term "install" shall mean only to fix in position, and "connect" shall mean to make electrical connections to. The term "Provide" shall mean to furnish and install.

1.3 LAWS, REGULATIONS AND CODES:

- A. Perform all work in strict compliance with all laws, regulations, and/or codes applying, including all Federal, State and local codes and any other authority having jurisdiction. Wherever drawings or specifications conflict with such regulations they shall be made to conform, and approval of the Design Professional obtained on such changes as may be involved.
- B. All electrical and telecommunications work shall comply with the requirements of the National Electrical Code, latest revision.

1.4 PERMITS, FEES, AND CERTIFICATES OF APPROVAL:

- A. Unless stated otherwise in General Conditions or Division 1, obtain and pay for all permits, fees, and licenses required, including those of utilities and Agencies. Provide copies to Design Professional in the quantity requested. "Fees" shall include connection charges construction costs, and other such charges by utility companies or service providers. Ascertain such charges during bidding period and include bid price.
- B. As a prerequisite to final acceptance, supply to the Design Professional a Certificate of Inspection from an Electrical Inspection Agency acceptable to the Owner and approved by the local municipality and the utility company serving the project. Certificate shall cover rough wiring, fixtures, and equipment.

1.5 RECORD DRAWINGS:

- A. During construction keep an accurate record of all deviations of the work as shown on the drawings and that which is actually installed.
- B. Secure from the Design Professional, a complete set of prints of the Telecommunications drawings and note changes thereon. Make a complete record in a neat and accurate manner, of all changes and revisions to original design which exist in completed work, in CAD file format.
- C. The cost of furnishing above CADD files and preparing these record drawings shall be borne by the contractor. When all revisions showing the work as finally installed are made, the corrected prints and CADD files shall be submitted for review and approval by the Design Professional.
- D. Record drawings shall be delivered to Owner within 30 days after acceptance of completed project by Owner.

1.6 OPERATING INSTRUCTIONS:

- A. Provide to the Owner three bound copies of complete written instruction on the operation, care and maintenance of each piece of equipment and the installation as a whole. Include frequency of inspection, cleaning and adjusting and other attention as may be required in accordance with manufacturer's instructions. Material shall be manufacturer's brochures, catalog cuts, parts lists, wiring diagrams, etc. Also supply Owner with three complete sets of approved shop drawings.
- B. Furnish qualified personnel to instruct the Owner's personnel in the maintenance and operation of all equipment and systems. Instructing personnel shall remain on the job continuously during working hours until such instruction is complete, but not less than 16 hours.
- C. In addition, refer to Division 1.



1.7 CORRECTION OF WORK AFTER FINAL PAYMENT AND GUARANTEE:

- A. This article is supplementary to Guarantee Provisions of Division 1 and General Conditions.
- B. Final payment shall not relieve the contractor of responsibility for faulty equipment, materials and workmanship, and unless otherwise specified, the contractor shall remedy any defects due thereto and pay for damage to other work resulting therefrom, which shall appear within a period of one (1) year from the date of acceptance.
- C. Include guarantees by the respective equipment manufacturers which shall be subject to the terms and time limits defined under this Article of Specifications.
- D. Guarantees furnished by Sub-contractor and/or equipment manufacturers shall be counter-signed by the related Prime Contractor for joint and/or individual responsibility for subject item.
- E. Manufacturers' equipment guarantees or warranties extending beyond the guarantee period described herein shall be transferred to the Owner along with the contractor's guarantees.

1.8 QUALITY ASSURANCE

- A. Comply with the requirements of the following codes and/or standards:
  - 1. ANSI.
  - 2. ANSI.
  - 3. UL.
  - 4. NEMA.
  - 5. NFPA.
  - 6. NEC.
  - 7. IBC 2009.
  - 8. BICSI.
  - 9. ANSI/TIA 568-D Series.
  - 10. ANSI/TIA 569-E.
  - 11. ANSI/TIA 606-C.
  - 12. ANSI/TIA 607-D.
- B. All packaged equipment shall be independently Third Party labeled as a system for its intended use by a Nationally Recognized Testing Laboratory (NRTL) in accordance with the OSHA Federal Regulations 29CFR1910.303 and .399, as well as NFPA Pamphlet #70 and National Electric Code (NEC), Article 90-7.

PART 2 - MATERIALS

2.1 MATERIALS AND EQUIPMENT:

- A. All installed materials and equipment shall be new and the best of their kind and shall conform to the grade, quality and standards specified herein.
- B. Unless otherwise specifically stated, all materials and equipment offered under these specifications shall be limited to products regularly produced and recommended by the manufacturer for the service intended. This material and equipment shall have capacities and ratings sufficient to amply meet the requirements of the project. The capacities and ratings shall be in accord with engineering data or other comprehensive literature made available to the public by the manufacturer and in effect at the time of opening of bids.

- C. Equipment shall be installed in accordance with manufacturer's instructions for type and quality of each piece of equipment used. These instructions shall be obtained from the manufacturer and shall be considered part of these specifications. Type, capacity, and application of equipment shall be guaranteed suitable to operate satisfactorily. No experimental material or equipment shall be permitted.

## 2.2 WORK DESCRIPTION:

- A. In general, the work shall consist of but not necessarily be limited to the following:
  1. Install Owner's pre-purchased equipment as required.
  2. Rough in and make final connections to equipment furnished by Owner or by other Trades.
  3. Installation of communications backbone cabling.
  4. Installation of communications horizontal cabling.
  5. Installation of data racks in MDF and IDF Room locations.
  6. Communications interface with Building Management Systems, audio visual, fire alarm, and security systems.
  7. Communication UL 497 bonding and grounding second level, with lightning protection.
  8. Outside plant low voltage service provider coordination.

## 2.3 WORK INCLUDED:

- A. In addition to work described above under WORK DESCRIPTION, the work shall include but not necessarily be limited to the following:
  1. Rigging of equipment and materials related to the Telecommunications Work.
  2. Provide and install all telecommunications racks and cabinets.
  3. Provide and install horizontal and vertical cable management.
  4. Provide and install horizontal UTP cabling.
  5. Provide and install backbone UTP and fiber optic cabling.
  6. Provide and install grounding and bonding of all systems in accordance with National Electrical Code and ANSI/TIA-607-D Standards and Requirements
  7. Provide testing of installed cabling to support telecom systems.
  8. Miscellaneous steel and hangers required for support of Telecom equipment.

## 2.4 CHASES AND OPENINGS:

- A. Provide information to the appropriate trades regarding size and location of all openings and chases as required for the installation of this Telecom Work.

## 2.5 CUTTING AND PATCHING:

- A. Provide all cutting and patching required for work performed under this Contract. No holes may be cut or drilled in structural members without prior approval of Owner's Representative. Cutting shall be done by mechanics skilled in their respective trades.
- B. No cutting that may impair the strength of the building construction shall be done. No holes may be drilled in or attachments welded to the beams or other structural members without prior approval from the Owner's Representative. All work shall be done by mechanics skilled in their trade.
- C. All patching shall be done in a manner to match appearances and quality of existing surfaces.

- D. Provide sleeves for conduits passing through poured concrete decks, footings, walls, etc. Cut all openings for conduits passing through precast concrete or existing concrete masonry. Such holes shall be cut with core drill or similar equipment. Sleeves shall not be cut with hammer or chisel, or with any power tool depending on impact for its cutting power.

## 2.6 SUBSTITUTIONS:

- A. Equipment may be shown or specified in several ways:
  - 1. Manufacturer and catalogue or model number with the words "no substitutions," "no equal," "(manufacturer) only," or words of similar respect. The contractor shall furnish the specified item.
  - 2. Several manufacturers and model numbers listed; or one manufacturer and model number, followed by "equals by (mfr A), (mfr B), (mfr C)," or words of similar respect.
    - a. If one of the manufacturers is listed on the drawings, that manufacturer shall be considered the basis of design. If none is so listed, the first manufacturer named in the Specification shall be considered the basis of design.
    - b. Where manufacturer's or supplier's name, style and catalog numbers are mentioned in the description of material and equipment in the specifications or on the drawings, it is to be understood that they are for the purpose of setting a standard.
    - c. If the contractor elects to furnish equipment other than the basis of design, he shall verify capacities, physical size, weight, electrical requirements, methods of connection to other parts of the system, and all other relevant data. The contractor shall be responsible for informing the Design Professional of all changes required to other equipment, spaces, structure or systems in order to install the substituted equipment. He shall furnish all required shop drawings or sketches required for Design Professional to evaluate the required changes and shall be responsible for all costs associated with such changes, including costs of design or engineering, if such are necessary, and costs of other trades.
  - 3. Where manufacturer's or supplier's names are listed in conjunction with the manufacturer or supplier that is basis of design, they are given to approve the firm name only. Equipment or material submitted by such firms must meet the detailed technical specifications written for the respective item. The contractor shall be responsible for verifying capacities, physical sizes, weights, electrical requirements, methodology for connections to other parts of the system, etc. The contractor shall furnish all required shop drawings for equipment, and for its connection and installation.
- B. If any substituted items are submitted after contracts have been awarded, and there is any question of equality of such items, samples may be required to be submitted both for the item specified and that to be substituted, or further proof of equality may be required to the entire satisfaction of the Design Professional. In no case shall additional remuneration be allowed because of the rejection of a substitute.
- C. When the equipment is relocated to a place other than that shown on the drawings, or when equipment other than that specified is used, the contractor shall pay any extra cost of required revisions such as structural steel, concrete, electrical, piping, etc.
- D. The Design Professional's costs to evaluate substitutions and to revise Drawings and Specifications because of substitutions will be paid by the contractor.

## 2.7 SHOP DRAWINGS:

- A. Refer to Division 1 and individual specification sections.
- B. Furnish shop drawings, catalog cuts, performance data and other required data to the Design Professional for approval for all material and equipment specified hereinafter. Sufficient data shall be submitted to show compliance with the requirements of the plans and specifications. All shop drawings submitted shall be first checked and corrected before submitting for approval. Approval for shop drawings by the Design Professional will not relieve the contractor from responsibility for errors or omissions therein. All such errors or omissions must be made good by the contractor irrespective of any approval by the Design Professional.
- C. The following applies to all materials and equipment being submitted for this project. Refer to the individual specification sections for additional submittal requirements.
- D. It is the responsibility of the manufacturer's representative and the installing contractor to thoroughly review all shop drawing equipment submittals and state in writing that the products meet or exceed the design specifications and design intent as indicated on the contract documents, prior to submitting them for review by the engineer.
- E. The General Contractor or Construction Manager shall review and stamp all shop drawings noting the CG/CM review process has taken place and that the shop drawings are in compliance with the design documents, prior to submitting the for review by the engineer. Any shop drawings found to not be in compliance shall be returned to the contractor stating such, with a copy of the statement (only) forwarded to the engineer.
- F. On submissions beyond the initial one, clearly identify changes made from the initial submittal other than those requested by the Design Professional will review only those changes that are requested and those identified by the contractor.
- G. The Engineer will review three submissions (one original submission and up to two revised submissions) on any single component requested for review. If the contractor and/or vendor fail to comply with the drawings, specifications, and/or review comments, and additional submissions are required, the cost for those submissions will be borne by the contractor.
- H. The design documents are based and coordinated on the scheduled manufacturers. Any substitutions of products or materials (from those approved and listed in the specifications) must be thoroughly coordinated by the submitting contractor. This includes but is not limited to power, space, structural, control and performance requirements.
- I. Shop drawings required shall include, but not necessarily be limited to, the following:
  - 1. Shop drawings, cuts and catalogue information showing appearance, dimensions, performance, weight, etc., of all equipment, fixtures, appurtenances, etc. See respective equipment or system sections for more specific requirements.
  - 2. Schedules of all materials showing type and manufacturer.
  - 3. Wiring diagrams and schematics for equipment.
  - 4. Telecommunications cabinets, racks, switchboards, panels, and other protective and distribution equipment.
  - 5. All special equipment and systems.
  - 6. Other shop drawings as may be requested.
- J. Electronic and facsimile submission of shop drawings will not be accepted as the submittal format. An advanced copy for starting the process may be E-mailed but hard copy submittals shall be submitted for actual review.

- K. Product Data: Include manufacturer's technical literature for each device. Indicate dimensions, capacities, performance characteristics, electrical characteristic, finishes for materials, and installation and startup instructions for each type of product indicated.
- L. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Schematic flow diagrams showing all controlled equipment and control devices.
  - 2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
  - 3. Details of control panel faces, including controls, instruments, and labeling.
  - 4. Written description of sequence of operation.
  - 5. Trunk cable schematic showing programmable control unit locations and trunk data conductors.
  - 6. Listing of connected data points, including connected control unit and input device.
  - 7. System graphics indicating monitored systems, data (connected and cSMSulated) point addresses, and operator notations.
  - 8. System configuration showing peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
- M. Shop Drawings shall be submitted and shall consist of a complete list of equipment and materials, including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. Shop drawings shall also contain complete wiring, routing, schematic diagrams, tag number of devices, software descriptions, calculations, and any other details required to demonstrate that the system will function properly. Drawings shall show proposed layout and installation of all equipment and the relationship to other parts of the work.
- N. Shop Drawings shall be approved before any equipment is installed. Therefore, shop drawings must be submitted in time for review so that all installations can be completed per the project completion schedule. Ten working days shall be allowed for submittals to be reviewed.
- O. All drawings shall be reviewed after the final system checkout and updated or corrected to provide "as-built" drawings to show exact installation. All shop drawings will be acknowledged in writing before installation is started and again after the final checkout of the system. The system will not be considered complete until the "as-built" drawings have received their final approval. The contractor shall deliver a complete set of "as-built" drawings.

**Shop Drawing Review Comment Definitions:**

**A> No Exception Taken:**

The shop drawing or equipment submittal as submitted is approved without exception. No changes or corrections required. The materials, equipment or system submitted can be released for fabrication and construction. No Further Submission Required

**B> Make Corrections Noted:**

The shop drawing or equipment submittal as submitted is not completely correct but is approved as noted. Make the corrections noted on the shop drawing or submittal. The materials, equipment or system submitted can be released for fabrication and construction once the corrections have been made. The submittal must be corrected and resubmitted for record unless noted by "E: Resubmit". See "E: Resubmit definition below.

**C> Submit Specified Item:**

The shop drawing or equipment submittal as submitted is missing a component of the system that it represents or is not of the approved and specified manufacturers. Submit the missing or incorrect item. The materials, equipment or system submitted cannot be released for fabrication and construction.

**D> No Further Submission Required:**

The shop drawing or equipment submittal as submitted is approved as noted. No changes or corrections required. The materials, equipment or system submitted can be released for fabrication and construction. No Further Submission Required.

**E> Resubmit:**

The shop drawing or equipment submittal as submitted is not approved. The shop drawing or equipment submittal needs significant corrections and does require another submission to verify that the comments and changes have been incorporated. Make the corrections noted on the shop drawing or submittal. The materials, equipment or system submitted cannot be released for fabrication and construction.

**F> Rejected:**

The shop drawing or equipment submitted is not as specified or a non-approved manufacturer or product and rejected.

**G> Resubmit for Record Only:**

Make the corrections noted on the shop drawing or submittal. The shop drawing or equipment submittal as submitted is approved with minor exception. Changes or corrections are required. The materials, equipment or system submitted can be released for fabrication and construction.

PART 3 - EXECUTION

3.1 VISIT TO SITE:

- A. Before submitting bid, the contractor shall visit the site of the work and be thoroughly familiarized with the conditions affecting the work. No extra payment will be allowed on account of extra work made necessary by failure to do so.

3.2 WORKMANSHIP:

- A. All work shall be installed in a first class, neat and professional manner by tradespeople skilled in the trade involved. All details of the installation shall be mechanically and electrically correct. Should the Design Professional direct removal, change, or installation of any equipments or systems not installed in a neat and workmanlike manner, such charges shall be made by the Electrical Contractor at no expense to the Owner.
- B. Equipment shall be installed in strict accordance with manufacturer's instructions for type and capacity of each piece of equipment used. The contractor shall obtain these instructions from the manufacturer and these instructions shall be considered part of these Specifications.

- C. Drawings and specifications have been prepared with best knowledge of conditions available at the time of design. If any obscurities or discrepancies exist, they shall be brought to the attention of the Design Professional before bids are submitted. If they are not discovered before bids are submitted, the Design Professional shall be notified and shall render decision. This decision shall be final.
1. Drawings and Specifications are intended to be complementary; items described or shown in one but not both are to be furnished as if fully shown or described in both locations.
  2. In case of conflict between provisions of the Specifications, the more stringent requirement shall govern. Where a requirement is applied to a specific product, condition, system, or Specification Section which conflicts with a more general requirement elsewhere, the specific shall supersede the general.
- D. Drawings are generally indicative of the work to be installed, but do not indicate all conduit bends, fittings, boxes, and specialties which may be required, or the exact locations of all conduits. The contractor shall investigate structure and finish conditions affecting the work and arrange this work; accordingly, furnishing such fittings as may be required to meet such conditions. The contractor is responsible for exercising proper judgment to arrange this work and materials so as to avoid interference with other trades.
1. Riser diagrams, details, and schematics generally indicate cabling to be used in various systems involved. This information may or may not be duplicated on the plans, but equipment shown on either plans or riser diagrams and schematics shall be provided as if shown on both.
  2. All grades, elevations, dimensions, and clearances of equipment shown on drawings are approximate and shall be verified at site.
  3. Where work or equipment is referred to in singular terms, such reference shall be deemed to apply to as many items of work or equipment as required to complete entire installation.

### 3.3 FIELD MEASUREMENTS:

- A. Before ordering any material or doing any work, verify all measurements at the building and site and be responsible for the correctness of same. No extra compensation will be allowed on account of differences between actual dimensions and measurements and those indicated on the drawings. Any difference which may be found shall be submitted to the Design Professional for consideration before proceeding any further with the work.

### 3.4 DELIVERY OF EQUIPMENT:

- A. Be responsible for delivery of equipment, unload, and store in a manner not to interfere with the operation of other trades. Additional expense incurred because of equipment or material delivery delays shall be assumed by the responsible contractor.

### 3.5 PROTECTION OF WORK:

- A. All work, equipment and materials shall be protected at all times. All raceway openings shall be closed with caps or plugs during the installation. All equipment shall be tightly covered and protected against dirt, water, plaster, paint and other foreign material or mechanical injury during entire progress of installation. Make good all damage caused either directly or indirectly by workmen employed to fulfill requirements of the Electrical Work.

### 3.6 REMOVAL OF RUBBISH:

- A. During the course of construction, periodically remove from the premises all rubbish resulting from work of this trade so as to prevent its accumulation. At the completion of the work contemplated under these Specifications remove from the building and site all rubbish and accumulated materials of whatever nature not caused by the other trades and leave work, and equipment free of all foreign matter including plaster, cement, and paint and leave in a clean, orderly, acceptable, and usable condition.

### 3.7 COORDINATION WITH OTHER TRADES:

- A. Work in conjunction with each of the other trades to facilitate proper and intelligent execution of work with minimum interference.
- B. Carefully examine all architectural and structural drawings for the building and drawings for electrical trade and mechanical trades and be responsible for the proper fitting of all material and equipment into the building as planned and without interference with other piping, ductwork, conduit, or equipment. Proper judgment shall be exercised to secure best possible headroom, door and window clearance, and space conditions throughout; to secure neat arrangement for piping, equipment, and conduit, and to overcome all local difficulties and interferences to best advantage. Approval for any and all changes to plans and specifications which may thus be incurred shall be obtained from the Design Professional before proceeding.
- C. The contractor shall prepare preliminary shop drawings suitable for use in coordinating this work with the work of other trades. The HVAC section will prepare and furnish reproducible prints at an appropriate scale with all trades indicating piping, ductwork and conduit in relation to all structural elements of the construction, including floor elevations; steel locations, size, and elevations; partitions locations; door locations and direction of swing; and all other information required to assure coordination of the electrical, sheetmetal and piping trades and fire protection in relation to the Architectural function of the project. Coordination meetings will be held under the supervision of the Owner's Construction Manager and General Contractor. Each trade shall have proper representation at all coordination meetings for the purpose of detailing, on a reproducible print mentioned above, the exact location and routing of their work.
- D. After the conclusion of the coordination at the working meetings, each trade shall sign the coordinated drawing, with copies being distributed by the GC to all contractors and parties concerned, including the Owner. Final shop drawings of all trades shall be in accordance with the coordinated drawing, which final shop drawings shall be submitted for final approval.
- E. If contractor installs work so as to cause interference with work of other trades, he shall make necessary changes in work to correct the condition without extra charge.
- F. Dimensional layout plans of equipment rooms shall be made showing all bases, pads and inertia blocks required for mechanical equipment. Include dimensions of bases, bolt layouts, details, etc.
- G. The contractor shall furnish all necessary templates, patterns, etc. for installing work and for purpose of making adjoining work conform, furnish setting plans, and shop details to other trades as required.

### 3.8 COORDINATION OF TELECOMMUNICATIONS CHARACTERISTICS:

- A. The contractor shall carefully examine the drawings of all other trades for equipment requiring telecommunications connection and shall ascertain that all telecom characteristics of equipment scheduled thereon matches the service available. If any discrepancies are noted, he shall



immediately refer to Design Professional for resolution. If characteristics are correct, the contractor is responsible for ascertaining method of connection, "rough-in" dimensions, correct plug, and receptacle configurations, etc. While Design Professional has made every effort to provide such information as is known at time of design, the contractor shall obtain final data from shop drawings before proceeding.

- B. For all equipment of other trades which electrical characteristics are not scheduled on drawings of that trade, the contractor shall assume the responsibility of notifying the General Contractor furnishing such equipment as to the characteristics required; the contractor will be held responsible for correction of all problems arising from failure to do so.

### 3.9 FIRESTOPPING:

- A. All penetrations through fire-resistance-rated floor, fire resistance rated, floor/ceiling assemblies and roof construction and through fire-resistance-rated walls and partitions shall be fire stopped.
- B. Penetrations to be fire stopped include both empty openings and those containing cables, pipes, ducts, conduits, and any other items.
- C. Fire rating of sealed penetrations shall meet or exceed the rating of the assembly being penetrated.
- D. Materials shall be installed in accordance with manufacturer's recommendations and UL listing.

END OF SECTION

## SECTION 270500

### COMMON WORK ELEMENTS FOR COMMUNICATIONS SYSTEMS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.
- B. Related Specification Sections:
1. Division 07 – Through-penetration Firestop Systems
  2. Division 26 – Common Work Results for Electrical
  3. Division 26 – Low Voltage Electrical Power Conductors and Cables
  4. Division 26 – Grounding and Bonding for Electrical Systems
  5. Division 26 – Hangers and Supports for Electrical Systems
  6. Division 26 – Raceways and Boxes for Electrical Systems
  7. Division 26 – Identification for Electrical Systems
  8. Division 27 – General Requirements for Telecommunications
  9. Division 27 – Common Work Elements for Communications Systems
  10. Division 27 – Network Communications Systems
  11. Division 27 – Two-Way Communications System
  12. Division 27 – Audiovisual Systems
  13. Division 27 – Nurse Call/Code Blue
  14. Division 28 – Common Work Elements for Electronic Safety and Security
  15. Division 28 – Physical Electronic Safety and Security
  16. Division 28 – Video Surveillance System
- C. Reference Symbols:
1. All device symbols are defined by the appropriate symbol schedule on the symbols and abbreviations sheet in the telecommunications systems drawing package. Not all device symbols as indicated may be required for the project.
  2. Because of the scale of the drawings, symbols are shown on drawings as close as possible to the mounting location. Contractor shall coordinate exact locations with all drawings and affected trades prior to submittal of shop drawings.
    - a. The Contractor shall coordinate exact locations with all security and telecommunications drawings and site plan drawings as well as all affected trades prior to submittal of any shop drawings.
- D. Abbreviations:
1. ACR Attenuation to Crosstalk Ratio.
  2. ADA Americans with Disabilities Act
  3. ASTM American Society for Testing Materials
  4. ASIS Formerly the American Society for Industrial Security, now known simply as ASIS International
  5. A/V Audio Visual Systems – For purposes of this specification section A/V systems shall include all Media Management, Video Broadcasting, Intercommunications (Paging/Public Address, Clock, Auxiliary Sound), Video Intercom, Emergency Communications, Mass Notification, Master Antenna (MATV) and Distance Learning Systems

6. AVI Audio Visual Systems Integrator: Shall be a qualified contractor experienced in the installation and certification of A/V systems. The AVI contractor shall be responsible for the design, testing, and certification of all audio/visual systems including, but not limited to: Intercommunications, TV Distribution, Audio Visual, Master Antenna and Bi-Directional Antenna systems as well as all structured cabling systems supporting these technologies.
7. BAS Building Automation System
8. BICSI Building Industry Consultant Services International - International organization whose primary objective is to enhance the reputation and skills of companies and individuals employed in the telecommunications and security industries by ensuring that current and developing standards are maintained.
9. CATV Community Antenna Television
10. CP Consolidation Point - Local Interconnection Point between horizontal cables from the building IDF/MDF rooms and horizontal cables for the furniture drops.
11. DDC Direct Digital Controller / Device Display Controller
12. DGP Data Gathering Panel – A component of the Physical Access Control System (PACS) located at each door or portal location that communicates, stores and processes information received from readers, reader modules, input modules, and output modules with the Security Management System CPU and software.
13. DMZ Demilitarized Zone – A firewall configuration for securing local area networks (LANs).
14. DP Demarcation Point - The point of interface between the Communications Networks, MATV, any Auxiliary Systems, and the associated Service Providers or Public Utilities. Also known as Entrance Facility. Shall also serve as the primary termination point for all incoming OSP cabling as well as the primary main grounding bus-bar for all communications systems. Refer to project documents for exact location and termination requirements.
15. ELFEXT Equal Level Far End Crosstalk.
16. EMI Electromagnetic interference.
17. EMT Electrical Metallic Tubing – Also known as thin-wall conduit.
18. FACP Fire Alarm Control Panel
19. FAS Fire Alarm System
20. FCC Federal Communications Commission
21. GFCI Ground fault circuit interrupter.
22. GUI Graphic User Interface – A specialized program employing graphical display maps of a facility and/or site which, also provides a manual user interface for all system functions and operations by utilizing control and annunciation icons from dedicated human machine interface terminals.
23. HMI Human/Machine Interface – A Computer-operated, video control terminal complying with FCC Part 15 CFR Title 47, Subparts A and B, and shall utilize multiple dynamic GUI based displays for annunciation and control LCD flat panel computer monitor or display screen as defined by related specification sections.
24. IBC International Building Code
25. ICT Information Communications Technology – For purposes of this specification section ICT shall include all communications systems including but not limited to all Data, Telephone, BAS, Intercommunications (Paging/Public Address), TV Distribution Systems (MATV) and Audio Visual Systems (A/V) Surveillance Systems and IP based Access Control.
26. ICTI Information Communications Technology Integrator – Shall be a qualified contractor experienced in the installation and certification of all data, telecommunications. The ICTI shall be responsible for the design, testing, and certification of Data, Telephone communications systems and all structured cabling systems supporting these technologies.

27.	IDF	Intermediate Distribution Frame – The room/space that shall serve as the local termination point for all horizontal and backbone cabling. Also, shall be known as Equipment Room (ER), Horizontal Cross-Connect (HC) or Floor Distributor (FD).
28.	IEEE	Institute of Electrical and Electronics Engineers
29.	IO	I/O Input/Out – Commonly associated with dry contact relay-based digital integration.
30.	IP	Internet Protocol
31.	IR	Infrared
32.	ISO	International Organization for Standardization
33.	LAN	Local Area Network
34.	LCD	Liquid Crystal Display
35.	LED	Light-Emitting Diode
36.	LV	Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
37.	MDF	Main Distribution Frame – The room/space that shall serve as the primary termination point for all backbone cabling to each IDF locations and horizontal connection point for local communication drops. May also serve as a local IDF location as well as the cross-connection and interconnection of all entrance cables from the DP for all PSTN and WAN connections. Also, shall be known as Main Cross Connect (MC), Telecommunications Room (TR) and/or Campus Distributor (CD)
38.	M-JPEG	Motion – Joint Photographic Experts Group
39.	MPEG	Moving picture experts' group
40.	NEC	National Electric Code
41.	NEMA	National Electrical Manufacturers Association
42.	NEXT	Near End Crosstalk
43.	NFPA	National Fire Protection Association
44.	NTSC	National Television System Committee.
45.	NRTL	Nationally Recognized Testing Laboratory
46.	NVR	Network Video Recorder
47.	NVW	Network Video Workstation
48.	OTDR	Optical Time Domain Reflectometer
49.	OSP	Outside Plant – All cabling associated with building services supporting the incoming service connections to Service Providers, Public Utilities, and Wide Area Networks.
50.	PA	Public Address or Building Intercommunications System.
51.	POTS	Plain Old Telephone Service – Analog Telephone Circuit used for the connection of fax machines, BAS and FAS communications devices and shall be wired upstream of the facility's telephone switch.
52.	PSP	Physical Security Professional as registered by the American Society of Industrial Security-International (ASIS)
53.	PSTN	Public Switched Telephone Network – Connection to local telephone utility providing local telephony communications service.
54.	RCDD	BICSI-accredited Registered Communications Distribution Designer
55.	RFI	Request for Information
56.	RGS	Rigid Galvanized Steel conduit – Galvanized steel tubing, with a tubing wall that is thick enough to allow it to be threaded.
57.	TCP/IP	A standard protocol stack on which the Internet and data communications networks operate
58.	TGB	Telecommunications Grounding Busbar – Located in each IDF
59.	TIA	Telecommunications Industry Association
60.	TMGB	Telecommunications Main Grounding Busbar – Located at the building DP/MDF
61.	TVSS	Transient Voltage Surge Suppressor
62.	UPS	Uninterruptible Power Supply
63.	UTP	Unshielded Twisted Pair
64.	VoIP	Voice Over IP telephone Network

- 65. VPN                    Virtual Private Network
- 66. WAN                    Wide Area Network
- 67. WAP                    Wireless Access Point
- 68. WLAN                    Wireless Local Area Network

E. Definitions:

- 1. Contract Documents: The documents consisting of the Form of Agreement between Owner and Contractor, Conditions of the Contract, (General, Supplementary, and other Conditions), Drawings, Specifications and all Addenda issued prior to the execution of the Contract.
- 2. Contract Drawings: The drawings that form a part of the Contract Documents that provides the graphical representation of the project requirements intended design and/or performance criteria to be delivered by the Contractor.
- 3. Reference Drawings: A drawing and/or set of drawings produced by a proprietary supplier, manufacturer, subcontractor, or fabricator included in the Contract Documents for informational purposes, providing specific information related to the installation of related appurtenances, components, devices, hardware, products, and/or systems. Reference Drawings shall also include any Contract Drawings from prior bid packages that may have pertinent information or require coordination of trades related to this contract.
- 4. Shop Drawings: A drawing and/or set of drawings produced by the contractor, supplier, manufacturer, subcontractor, or fabricator as a detailed representation of the proper installation of the related, appurtenance, component, device, hardware, product, and/or system to be delivered in conformance to the requirements of the Contract Documents.

1.2 SUMMARY

A. This Section contains the overall requirements associated with all Division 27 and Division 28 Specification Sections, and includes the project design intent for all data, voice, and security network communication cabling and equipment related to the installation of the following systems:

- 1. Network Communications System
- 2. Video Surveillance System
- 3. Physical Access Control System (PACS)
- 4. Audiovisual System

B. In addition, this section shall address all requirements for submittals, quality assurance, product handling, record documents, project conditions, installation, system performance, demonstrations, testing, and certifications for all scopes of work related to network communication cabling for this project scope of work. Refer to related Division 26, 27 and 28 specification sections and all contract drawings for additional information.

- 1. The ICTI shall have overall responsibility for all designs, equipment and all technical support related to all Division 27 scopes of work and shall ensure full coordination of all work as required to provide the following fully operational communications network in accordance with all related specification sections and contract drawings.
  - a. The ICTI shall be responsible for providing all equipment, devices, system components, final cable terminations, programming, commissioning, and testing of all network communications cabling and equipment in accordance with all related Division 27 specification sections.
  - b. All sub-contractors shall meet the minimum technical capabilities, certifications, and licensing requirements as defined by the "Quality Assurance" chapter.

- C. The installation, performance, features, functions, software, and programming criteria as specified herein as well as all related Division 27 specification sections have been designed to offer the maximum system efficiency, ease of operation, occupant safety and the protection of equipment as recommended by The Owner and Design Professional.
1. Any deviations from the specified criteria shall be documented, reviewed and agreed to in writing by The Owner and the Design Professional prior to submission of bids. Refer to Division 01, and all related Division 27 specification sections for any substitutions and/or project deviation requests.
    - a. The required information shall include but not be limited to: reason for deviation, all differences in performance, operation and function from the herein specified requirements, all benefits and added features to The Owner as a result of the deviations and any additional incurred costs to The Owner for maintenance and long-term ownership.
    - b. Failure to provide the Owner and Design Professional with the required information shall result in any shop drawing submissions being returned for non-conformance with the contract requirements.
  2. The contractor and all sub-contractors for this work shall have read all of the General Conditions, Special Requirements, General Requirements and all related specification sections and in the execution of all work shall be bound by all of the conditions and requirements therein.
  3. Prior to the submission of the Bid any discrepancies or inconsistencies noted within these specifications and/or the project drawings shall be brought to the immediate attention of the Owner and Design Professional.
- D. All device symbols are defined by the appropriate symbol schedules as indicated by the symbol and abbreviation drawing sheets for each discipline. The Contractor shall coordinate exact locations with all architectural, mechanical, electrical, reflected ceiling, furniture drawings and door hardware specifications as well as all affected trades prior to submittal of bids.
1. All symbols are shown on the contract drawings as close as possible to their intended location. Contractor shall coordinate the installation of all equipment, devices, controls, components, cabling conduits/raceways and integration of other systems with all affected trades and specified system integrators. The contractor shall document all coordination requirements at the time of shop drawing submission.
  2. Drawings for this work are diagrammatic and intended to convey the extent, general arrangement, and locations of the work. Because of the scale of the drawings, certain basic items such as access panels, conduits, cabinet sizes, penetration sleeves, pull boxes, back-boxes and junction boxes may or may not be shown on the contract drawings. Include all items where required by code and related specification sections for proper installation of all work.
- E. Where ambiguity exists between the project specifications and the contract drawings, the superior in system performance regardless of cost shall prevail and shall be delivered by the Contractor at no additional expense to the project.
- F. Project specifications and drawings may not deal individually with every part, control, device, component, or appurtenance which may be required to produce the equipment performance for the specified system and/or as required for compliance with all specified systems integration.
1. Include such items and components, as required, for complete operational systems as defined by the project documents, whether specifically indicated or not. The contractor shall be responsible for providing conduits/raceways, cable terminations, controls, systems, equipment, materials, devices, components, electrical power, equipment racks/cabinets, software, programming, commissioning, testing and all appurtenances as well as the integration of any ancillary systems or Owner provided

- equipment/components/systems.
- 2. Coordinate with other applicable trades in submittal of shop drawings and the installation of all systems. All shop drawings shall detail space conditions in order to accommodate other concerned trades, all equipment locations are subject to final review by the Owner and Design Professional.

G. Use of Premises

- 1. General: The Contractor shall have limited use of premises for construction operations only as required to meet the scope of work as delineated by the Contract Documents.
- 2. The Contractor shall design, prepare, schedule, and coordinate all scopes of work without disruption of any existing system functions or the daily operation of the facility. All communications cabling and equipment shall be installed in such a manner that all new controls, equipment and/or devices shall be installed, programmed, and tested prior to switch over and/or disconnecting of any existing communications systems.
- 3. The contractor shall coordinate all installation activities so as not to disrupt the daily routines of the facility and shall include any costs related to a phased construction methodology including but not limited all necessary temporary equipment, devices, components, or systems as well as any labor costs associated with any installation, commissioning, testing demolition of any systems required to be performed after normal business hours of the facility.
  - a. Contractor shall plan, schedule, and install all communications cabling and equipment in accordance with all requirements of the project construction schedule. Refer to related specification sections for additional information related to project scheduling and facility access.
  - b. The contractor shall coordinate all installation and demolition activities so as not to disrupt the daily routine of the facility or negatively impact the integrity of the facility's security and life safety measures.
  - c. Contractor shall demolish all existing network communications systems, cabling, devices, components and/or controls not integrated with the new telecommunications system at the completion of each project phase and only after final acceptance by Owner, Owner Representatives, and the Design Professionals. The removal or demolition of all existing system devices and/or field wiring not incorporated into the new systems shall be performed in such a manner consistent with all requirements of NFPA 70.

1.3 REFERENCES

- A. References to industry and trade association standards as well as all building codes are minimum installation requirements. The codes, standards, and agencies listed below shall form a part of this specification section and all work shall comply with the latest adopted standards.
- B. Where the contract drawings and specifications mandate a greater requirement or performance than those specified by any of the below referenced codes and standards, the Contract Documents shall then be the governing requirements for this project. The minimum codes and standards to be applied for this project shall be the following:
  - 1. All applicable requirements of NFPA 70 "National Electrical Code" including, but not limited to:
    - a. Article 250, Grounding
    - b. Article 300, Part A. Wiring Method
    - c. Article 310, Conductors for General Wiring
    - d. Article 725, Remote Control, Signaling Circuits
    - e. Article 770, Optical Fiber Cables, and Raceways
    - f. Article 800, Communication Systems

2. National Fire Protection Association:
  - a. NFPA-72: National Fire Alarm and Signaling Code
  - b. NFPA-75: Standard for the Protection of Electronic Computer/Data Processing Equipment
  - c. NFPA 90A: Standard for the Installation of Air-Conditioning and Ventilating Systems
  - d. NFPA 92A: Standard for Smoke-Control Systems
  - e. NFPA-99: Standard for Health Care Facilities
  - f. NFPA-101: Life Safety Code
  - g. NFPA-130: Standard for Fixed Guideway Transit and Passenger Rail Systems
  
3. ANSI/TIA Compliance: Comply with the following Electronics Industries Association Standards:
  - a. ANSI/TIA-568C: "Commercial Building Telecommunication Standard"
  - b. ANSI/TIA-569: "Commercial Building Standard for Telecommunications Pathways and Spaces"
  - c. ANSI/TIA-455: "FOTP-61, Measurement of Fiber or Cable Attenuation Using an OTDR"
  - d. ANSI/TIA-606: "The Administration Standard for the Telecommunications Infrastructure of Commercial Building"
  - e. ANSI/TIA-607A: "Commercial Building Grounding and Bonding Requirements for Telecommunications"
  - f. ANSI/TIA-492A: "Detail Specification for 850-nm Laser Optimized 50- $\mu$ m Core Diameter/125 $\mu$ m Cladding Diameter Class 1a Graded Index Multi-Mode Optical Fibers"
  - g. ANSI/TIA-492CAAA: Detail Specification for Single-Mode Optical Fiber
  
4. Underwriters Laboratories, Inc.:
  - a. UL 486A: "Wire connectors and soldering lugs for use with copper conductors"
  - b. UL 1449: "Transient voltage surge suppressors"
  - c. UL 1581: "Standard for Electrical Wires, Cables, and Flexible Cords"
  - d. UL 478: "Standard for Electronic Data-Processing Units and Systems"
  - e. UL 83: "Thermoplastic-Insulated Wires and Cables,"
  - f. UL 910: "Test Method for Fire and Smoke Characteristics of Cables Used in Air-Handling Spaces." Provide products which are UL-listed and labeled.
  - g. UL 1069: Hospital Signaling and Nurse Call Equipment
  
5. Federal Communications Commission:
  - a. FCC Regulations Part 15 Title 47.
  
6. Institute of Electrical and Electronic Engineers (IEEE)
  - a. IEEE 802.3 - "Carrier Sense Multiple Access with Collision Detection," and all applicable supplements a through af".
  - b. IEEE 802.3.u-100 - "Base T/100-Base-TX, Fast Ethernet"
  - c. IEEE 802.3.z - "Gigabit Ethernet"
  - d. IEEE 802.3.ab - "1000 Base T"
  - e. IEEE 802.3.ae - "10 Gigabit Ethernet"
  - f. IEEE 802.3.af - "Data Terminal Equipment (DTE) Power via Media Dependent Interface (MDI) that"
  - g. IEEE 802.11.ax - "Wireless Transmission Standard"
  - h. IEEE 802.11.bt - "Power over Ethernet"



7. ISO/TC - International Organization for Standardization's (ISO) Technical Committee (TC)
  - a. 21730 - Health informatics - Use of mobile wireless communication and computing technology in healthcare facilities.
8. NEMA/ICEA Compliance:
  - a. WC-5 - "Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy,"
  - b. WC30 - "Color Coding of Wires and Cables," pertaining to control and signal transmission media.
9. ASTM Compliance: Comply with applicable requirements of D-2219 and D-2220. Provide copper conductors with conductivity of not less than 98% at 20°C (68°F).
10. BICSI -TDMM 13th edition
11. ADA Standards for Accessible Design
12. Local Authority Having Jurisdiction
13. National Electrical Manufacturers Association (NEMA)

#### 1.4 SUBMITTALS

- A. In addition to all submittal requirements as stipulated by Division 01 specifications sections, the Contractor shall provide all shop drawing submittals in accordance with the following:
  1. Owner and Design Professional approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage, or installation of equipment or material which has not had prior approval will not be permitted at the job site.
  2. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings, and other data necessary for The Owner to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
  3. Submittals shall be provided as a complete submission; no partial submissions will be accepted. Failure to provide a complete submission shall result in all submittals being returned for resubmission.
    - a. In addition to all paper submission requirements as stipulated by Division 01 the Contractor shall also submit one complete set of electronic submittals in a PDF format.
  4. No substituted equipment shall be reviewed without prior approval in accordance with the requirements of "substitutions" under Division 1 specification section.
  5. Mark the submittals, "SUBMITTED UNDER SECTION \_\_\_\_\_."
    - a. Submittals shall be marked to show specification reference including the section and paragraph numbers.
  6. The Contractor shall schedule submittals in order to maintain the project schedule. For coordination requirements refer to Division 01 Specification Sections, which outline basic submittal requirements and coordination. All Division 01 Specification Sections requirements shall be used in conjunction with this specification section.
  7. Prior to any submission the contractor shall be responsible for performing the following quality control items to ensure compliance with all project requirements:
    - a. Review all Shop Drawings and Product Data
    - b. Review all field measurement criteria.
    - c. Review all field construction criteria and methodologies.
    - d. Review all catalog numbers and similar data.

- e. Review all coordination requirements of affected trades.
  - f. Review conformance to all appropriate specification sections.
8. All shop drawings shall be prepared using latest version of AutoCAD or REVIT, drawn accurately, and in accordance with The Owner's Standards. The Contractor shall not reproduce the Contract Documents or copy standard information as the basis of the technical data, hand drawn mark-ups of the original project drawings shall not be acceptable. Failure to provide a complete set of "contractor prepared" installation drawings at the time of submittal shall result in all submittals being returned for resubmission.
9. Submission Packaging: The Contractor shall organize the submissions according to the following packaging requirements.
- a. Electronic Copy Submission: One complete set of electronic equipment data sheets and drawings submitted in PDF format and collated in two distinct files:
    - 1) Equipment Data Sheets, equipment schedules, alarm matrixes cable termination spread sheets, and all related pertinent information.
    - 2) Drawings including all site plans, floor plans, risers, point to point wiring, grounding, installation details and mounting elevations.
  - b. Hard Copy Submission: Submit hardcopies of all shop drawings and product datasheets in accordance with the requirements the of Division 01 specifications.
10. The ICTI shall have an RCDD professional review all shop drawings related to network designs, installations, testing, certifications, and structured cabling layouts for communications systems. Failure to provide RCDD sealed shop drawings shall result in all shop drawings being returned for resubmission without any reviews taking place.
11. The Owner's and the Design Professional's review of the shop drawings and/or samples does not relieve the Contractor from compliance with the requirements of the project documents. Unless the Contractor has informed The Owner and the Design Professional in writing of such deviation at the time of submission, has noted the deviation on the shop drawings, and the Owner and the Design Professional has given written approval of the specific deviation to the project document.
- a. All project requirements shall stand. The Owner's and the Design Professional's review does not relieve the Contractor from responsibility for any errors of omission in the submission of shop drawings and/or samples.
12. Submit all system testing, commissioning, and startup procedures to be employed. Include all estimated times for performance of all tests, all test equipment and workforce necessary for testing.
13. Submit all qualifications and certifications in accordance with the requirements as specified elsewhere in this specification section.
14. Submit project schedule outlining the time frames for all equipment with long lead times for equipment deliveries; include all system commissioning, testing, and training time expectations. Project schedule shall be submitted as CPM schedule and shall utilize a software-based project management program.

B. Shop Drawings:

- 1. All shop drawings shall include sufficient information, clearly presented, to determine full compliance with all project drawings and specifications. Include the following information as applicable for review; failure to provide all information listed below shall result in all shop drawing submittals being returned for resubmission:
  - a. All Building Floor and Site Plans.

- b. All equipment, devices and components with manufacturer's name(s), model numbers,
  - c. All equipment, device and component electrical ratings and power requirements
  - d. All equipment, device, and component performance ratings.
  - e. All equipment /device cable voltage drop calculations,
  - f. All dB losses for all fiber optic devices and cabling,
  - g. All Speaker taps, voltages, and zoning
  - h. All equipment rack/cabinet layouts and rack/cabinet sizes.
  - i. All device-mounting elevations.
  - j. All device wiring details.
  - l. All grounding and bonding connections.
  - m. Complete point-to-point-wiring diagrams for all systems. Include all equipment and wiring termination schedules and/or matrices.
2. Provide a complete set of "contractor prepared" installation drawings. Drawings at the minimum shall consist of floor plans indicating all; passive and active electronic component locations, field devices, device identifications, distribution racks, patch panels, control panels, auxiliary control panels, power supplies, conduit, and cable requirements as well as all 120-volt electrical circuit locations and designations.
- a. Drawings shall include at the minimum the following:
    - 1) Detailed equipment layouts for all communications rooms. Coordinate all room layouts with affected trades.
    - 2) Floor plan drawings showing locations of all equipment, devices, equipment cabinets and/or rack locations. Identify type and sizes of all equipment cabinets and/or racks.
    - 3) All cable tray layouts, and conduit routing of all conduits 2 inches in diameter or greater.
    - 4) System riser diagrams and single line drawings
    - 5) Equipment wattage for each location and estimated BTU production.
    - 6) Detailed equipment layouts for all equipment consoles. Indicate all equipment locations, power connections and installation details.
    - 7) All equipment mounting hardware/brackets and installation details. Identify type size, load capacities of all mounting hardware/brackets; include all mounting and installation details, all space requirements, any special architectural modifications required.
    - 8) Outline drawings of all equipment cabinets/racks showing the relative position of all major components, all-wiring and grounding terminations. Include all panel, cabinet and/or rack dimensions.
    - 9) All grounding and bonding termination points
3. Provide a complete termination schedule of all communications device drop/outlet locations; indicate on the installation drawings all device drops/outlets' unique identification which shall correspond with schedule and drawings.

C. Equipment Submittals:

- 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - a. Include all equipment data sheets pertinent to equipment provided. All data sheets shall be highlighted and annotated indicating specific equipment and options supplied. Failure to provide the proper annotation of all equipment shall result in submittals being returned for resubmission.

2. Submit complete technical data necessary to evaluate the material and equipment. Include a complete technical specification for the submitted equipment, noting differences and adherence to this Section. Failure to provide the required data will result in all submittals being returned for resubmission.
  3. Submit performance data, equipment ratings, cable requirements, control sequences, GUI based control panels, programming matrixes, logic diagrams and all other descriptive data necessary to describe the installation and operations of the system being provided. Failure to provide the required data will result in all submittals being returned for resubmission.
  4. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price, and availability of each part.
- D. Maintenance and Operation Manuals: Submit in accordance with all requirements of Division 01 specification sections and as herein specified.
1. Maintenance and Operation Manuals: Submit as required for systems and equipment specified in the technical sections. Furnish in electronic format. Furnish one complete manual as specified in the technical section but in no case later than prior to performance of systems or equipment test and furnish the remaining manuals prior to contract completion.
  2. Inscribe the following identification on the cover: the words "Maintenance and Operations Manual", include the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment.
  3. Provide a "Table of Contents" and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
  4. Furnish (1) digital copy of all Maintenance and Operation Manuals in PDF format.
  5. The manuals shall include:
    - a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
    - b. A control sequence describing start-up, operation, and shutdown.
    - c. Description of the function of each principal item of equipment.
    - d. Installation and maintenance instructions.
    - e. Safety precautions.
    - f. Diagrams and illustrations.
    - g. Testing methods.
    - h. Performance data.
    - i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.
    - j. Appendix; list qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.
  6. Approvals will be based on complete submission of manuals together with shop drawings.

## 1.5 QUALITY ASSURANCE

- A. Integrator Qualifications: The projects' Information Communication Technology Integrator (ICTI) shall be an accredited and authorized distributor of the appropriate equipment manufacturer and shall be fully certified in the installation, testing and programming of all equipment being provided.

1. The ICTI shall be capable of providing documented successful work experience of at least three (3) facilities of equivalent size and technical requirements utilizing the proposed equipment being provided and have on staff a minimum of one full time individual that holds a current RCDD registration.
2. Cable Installer Qualifications: The cable installation contractor shall demonstrate not less than three (3) years' experience in the installation of structured cabling systems and shall have on staff a minimum of one full time member that holds a current BICSI level II installer credential.
  - a. NOTE: The installation of all communications cabling shall be under the direct supervision of a current BICSI level II installer who shall be knowledgeable in the following technical applications:
    - 1) The Routing and installation of shielded, unshielded, twisted pair, coaxial and fiber optic cables.
    - 2) Bonding and grounding of cable tray and equipment racks.
    - 3) Fusion splicing of fiber optic cabling.
    - 4) Testing copper conductors for electrical continuity.
    - 5) Testing and Certifying of UTP structured cabling for attenuation and worst case near end cross talk.
    - 6) Testing and Certifying of ALL fiber optic cabling employing an Optical Time Domain Reflectometer (OTDR) in accordance with TIA protocols.
    - 7) Testing and Certifying of coaxial cable networks for RF leakage
    - 8) Termination, connection, and testing of shielded and un- shielded twisted pair cable, coaxial cabling and fiber optic cabling on all specified connectors, electrical protection blocks, termination blocks and patch panels.
    - 9) Generally accepted industry standards, as well as manufacturers written installation instructions, will be used for in-process quality control and final acceptance of the work installation.
3. The Owner and the Design Professional reserve the right to require the Contractor to submit a list of installations where the products have been in operation before approval.
  - a. Experience shall be defined as the completion of the specific system being provided, with that system being successfully operated by the Owner for its intended purpose for at least three (3) years.
  - b. In addition to the above, "Experience" shall also be defined as the completion of modifications and renovations to any associated system being provided in any existing occupied facility of this size and magnitude.
  - c. For each facility submit the following:
    - 1) Name and location of facility
    - 2) Date of Occupancy or beneficial use by Owner
    - 3) Owner's representative to contact and telephone number
    - 4) Construction Manager or General Contractor
    - 5) Project Architect or Engineer
    - 6) Provide information on the installed locations with operational equipment
    - 7) Registration number and expiration date of RCDD professional
    - 8) Registration number and expiration date of Level II installer.
4. Service Qualifications: The ICTI shall be a permanent service organization maintained and/or trained by the product manufacturer on the products being provided for this project.
  - a. The ICTI shall be (where required) properly licensed by the governing municipality to provide the services and work for the specific system being installed. In addition, all integrators shall be capable of providing full service for the entire warranty period within an 8-hour response time upon notification of a service emergency.

- B. Manufacturer's Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and materials specified for this project, and shall have manufactured the items for at least three years.
  - 1. Product Qualification: The Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
    - a. The manufacturers shall submit the appropriate documentation certifying that the project ICTI is a qualified service provider of all manufacturers' products being provided for this project.

## 1.6 RECORD DOCUMENTS

- A. In addition to all general provisions of the Contract, including but not limited to all; General and Supplementary Conditions, Division 01 Specification Sections include the following project requirements:
  - 1. Provide complete set of finalized copies of record documents prior to final acceptance of the project by The Owner and the Design Professional in accordance with all requirements of Division 01 specification sections. At the minimum the record documents shall contain all information, data and drawings as described in Chapter 1.4 "Submittals" of this specification section.
    - a. As-built documents shall be submitted in both paper and electronic media formats in the quantities as specified by Division 01 specification requirements.
      - 1) All electronic record drawings shall be prepared and submitted utilizing an AutoCAD- or REVIT-based program as manufactured by Autodesk. Where electronic documents are prepared using other than an AutoCAD or REVIT program manufactured by Autodesk, the contractor shall provide to The Owner and Design Professional the necessary software to electronically view the submitted documents.
      - 2) All electronic data sheets, control sequences, programming matrixes and other descriptive data shall be provided in PDF formatted documents.
      - 3) Copies of all current system programming and associated software shall be provided on downloadable media formatted for the use in restoration all system operations and functionality in the event of a catastrophic failure.

## 1.7 EXTRA MATERIAL

- A. In addition to all general provisions of the Contract, including but not limited to all; General and Supplementary Conditions, Division 01 Specification Sections refer to related specification sections "Extra Material" for specific requirements.
- B. All Extra materials shall be provided at the time of final acceptance of the project and a signed packing list shall be obtained at the time of delivery. At no time is the contractor to use the extra materials provided for this project to replace malfunctioning or damaged equipment and or components.
- C. Provide 5% of all material as "Extra Material."

## PART 2 – PRODUCTS

### 2.1 MANUFACTURED PRODUCTS

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, that meet and/or exceed the specified performance

and features of the equipment and/or systems and for which replacement parts shall be readily available to the system integrator and/or using agency.

1. When more than one unit, device, or component of the same class of equipment is required, such units, devices or components shall be the product of a single manufacturer.
2. Acceptable manufacturers for each system shall be as specified and shall be provided in full compliance with the requirements of this and all related specification sections and contract drawings.
  - a. Manufacturers listed as acceptable shall not negate the contractors' responsibility for providing all equipment, devices, components and/or systems, in accordance with all functions and performance requirements of the Contract Documents.
  - b. Where manufacturer and/or manufacturer model numbers reference specific system components in the related specification sections, it is to establish the performance requirements and quality of the systems and components only.
    - 1) It is in no way an inference that the referenced model numbers are the manufacturer's current product and are the only acceptable components for this project unless specifically referenced as "no substitutions."
  - c. The Contractor shall provide the manufacturers' most current product that shall meet and/or exceed the specified performance and features of the equipment and/or systems.
  - d. Equivalent UL-listed equipment may be substituted for the approved manufacturers unless stipulated by other specification sections as "No Substitutions." All substitutions shall be submitted for approval by The Owner and the Design Professional in accordance with all requirements of Division 01 specification sections and Chapter 1.4 "Submittals" of this specification section.
    - 1) Where systems and/or components are referenced as "no substitutions" the specific system and/or components shall be provided.
    - 2) All substitutions shall comply with all requirements as specified above and all system performance standards shall be maintained.
    - 3) The contractor shall stipulate the following information impacted by such a substitution.
      - a) Any and all extensions in time impacted by the substitution.
      - b) Any changes to the architectural or structural elements to the project
      - c) Differences in operation and/or performance from intended system criteria.
    - 4) Failure to provide the required substitution information shall result in "without consideration" the immediate rejection of the substituted equipment and/or systems.

B. Equipment Assemblies and Components:

1. Components of an assembled unit need not be products of the same manufacturer.
  - a. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
  - b. Components shall be compatible with each other and with the total assembly for the intended service.
  - c. Constituent parts which are similar shall be the product of a single manufacturer.
  - d. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.

- C. Compatibility and Interoperability of System Components and Devices
1. Where multiple components, devices and/or systems are intended to be interconnected and components of a complete system in accordance with any related specification sections, it shall be the Contractor's responsibility to verify interoperability and compatibility of said components, devices and/or systems in full conformance to the specified performance criteria prior to the submission of shop drawings.
  2. Where specified devices are found to be incompatible or incapable of performing as specified in a seamless manner, the contractor shall notify the Engineer in writing prior to submission of shop drawings. Failure to properly identify such functional discrepancies shall not relieve the contractor from providing a complete and fully functional system in accordance with the requirements of all related specification sections.
- D. Where Factory or Off-Premises Testing of any equipment, product or assembly is recommended by the product manufacturer or where specified as part of this section and/or any related specification section:
1. The Owner, the Design Professional and/or Owner representatives shall have the option of witnessing all factory tests. The Contractor shall notify The Owner and the Design Professional at a minimum of thirty (30) working days prior to the performance of any factory or off-premises tests.
    - a. Where the factory or assembly point for all off-premises testing is not within two (2) hours driving time from the project location, the system integrator shall include as part of this project all per diem costs (travel, meals, and lodging) for a minimum of two representatives from the using agency and the project Design Professional to witness all testing.
  2. Provide four (4) copies of certified test reports containing all preliminary test data and testing procedures shall be furnished to The Owner and the Design Professional prior to any final testing and not more than ninety (90) days after completion of any tests.
  3. When equipment, product or assembly fails to meet any factory or off-premises tests, retesting of equipment, product or assembly shall be mandated, the manufacturer/integrator shall be liable for all additional expenses, including all expenses incurred by The Owner and the Design Professional for witnessing the retesting of any equipment, product, or assembly.

### PART 3 – EXECUTION

#### 3.1 EQUIPMENT PROTECTION

- A. Protect all materials, equipment, devices, or components permanently installed and/or stored on the job site. Protect all materials, equipment, cabling, devices, or components during construction and after installation. Provide appropriate protection of all materials, equipment, components and/or devices until time of substantial completion. All materials, equipment, components and/or devices shall be protected during shipment and storage against any physical damage, dirt, moisture, cold, snow, wind, or rain:
1. During installation, enclosures, racks/cabinets, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected against entry of any foreign matter; and shall be vacuum cleaned both inside and outside before testing and operating and repainting if required.
  2. Any materials, equipment, components and/or devices, stored on site, which have been deemed by The Owner or the Design Professional to exhibit any indications of damage or exposure dust or moisture shall not be installed and shall returned to the source of supply for immediate replacement.



- a. The use of spare parts or the return of defective equipment for repair to mitigate the damage of defective materials, equipment, components and/or devices shall not be acceptable. All materials, equipment, components and/or devices shall be new and unused until final acceptance by the Design Professional.
  - 3. Provide and apply protective material immediately upon receiving the products and maintain throughout the construction process.
    - a. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
    - b. Any damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired area is not obvious or detectable.
  - 4. Failure to properly protect all materials, equipment, components and/or devices prior to final acceptance shall constitute sufficient cause for rejection of materials, equipment, components and/or devices should any defects, damage or degradation in performance is observed.
- B. Seismic Performance: All equipment, bracing, and anchoring shall be rated for the seismic zone of the geographical area in which the project resides and shall withstand the effects of earthquake motion and wind forces in accordance with the current editions of the IBC and ASCE/SEI 7. Refer to Refer to Division 01 and Division 26 – Hangers and Supports for additional seismic information and requirements.
- 1. Equipment shall include, but not be limited to, racks/cabinets, cable/basket/ladder tray, conduit, cameras, and all appurtenances.
- C. Immediately replace all malfunctioning materials, equipment, components and/or devices with new unused products up until the time the Design Professional issues final acceptance of the system. The returning of any malfunctioning equipment, devices and/or components to the manufacturer for repair and then reinstallation at the project site shall not be acceptable.
- 1. All replacement materials, equipment, components and/or devices shall be factory new and not scavenged from the Project's spare parts inventory or factory recycled products unless expressly identified by contractor prior to replacement and approved beforehand by the Design Professional.

### 3.2 WORK PERFORMANCE

- A. Installation, final termination, testing, start-up and commissioning of all systems, system components and cabling infrastructures shall be under the direct supervision of the appropriate system integrator. The integrator shall be an accredited and authorized distributor of the appropriate equipment manufacturer and shall be fully certified in the installation, testing, commissioning, and programming of all equipment, devices, components and/or systems being provided as part of this project.
- B. Job site safety and worker safety is the responsibility of the Contractor. Ensure that safe access and egress from all work areas is maintained during movement and installation of materials. Clean up all debris generated by installation activities. Keep all communication equipment rooms free of debris at all times.
- C. Pre-installation Conferences: Include provisions to attend all pre- installation conferences at Project site in compliance with all requirements in Division 01 specification section and as herein specified. Review methods and procedures related to installation and operations of all communications systems, including, but not limited to, the following:
  - 1. Inspect and discuss electrical and equipment roughing-in related to all communications

- 2. Review and discuss all work, equipment deliveries, installation procedures and related scopes as required to conform to the phased construction schedule.
    - 3. Review sequence of operations for each type of system, control, cabling and/or integration to any systems and/or equipment provided by other trades
    - 4. Review and finalize construction schedule and verify availability of materials, installation personnel, equipment, and any preparatory work by other trades needed to make progress and avoid delays.
    - 5. Review required start-up, testing, commissioning, and certifying procedures to be employed for each system and any impacts to other trades.
  - D. For work on existing facilities, arrange, phase, and perform work to assure the operation of all communications systems for other buildings and contiguous spaces at all times. Refer to Division 01 specification section for additional information.
  - E. All new work shall be installed and connected to existing work neatly and carefully. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Division 01 specification sections.
  - F. Coordinate the installation of all cabling, conduits/raceways and cable trays and equipment with applicable trades to ensure proper operation and function of all integrated systems in accordance with all related specification sections. Refer to Division 01 specification section for additional project coordination requirements.
    - 1. Coordinate with all trades at the time of shop drawing submission detailing all space and/or room conditions. The contractor shall coordinate with the appropriate trade all conditions impacting the installation of any system, conduit or cable tray including but not limited to all equipment locations, site conditions, ceilings, lighting fixtures, fire protection piping and ductwork layouts to the satisfaction of all concerned trades, subject to final review by the Design Professional.
      - a. Coordinate exact location of all desktop/counter/wall mounted equipment with The Owner, the Design Professional, and all affected trades prior to the installation of any equipment and/or cabling.
      - b. Coordinate exact location(s) of all cable, conduits, equipment and/or devices installations with all architectural plans, site plans, reflected ceiling plans and affected trades prior to installation.
        - 1) Equipment installations requiring coordination with other trades the contractor shall provide all templates, back-boxes and equipment anchor bolts for mounting or flush mounting preparation, (e.g., pedestals or other devices requiring mounting on walls, concrete pads or other materials). Coordinate delivery of templates and equipment anchor bolts to preclude any delay in the construction schedule or the work of the affected trade.
      - c. If installation of equipment, devices, cabling, raceways, cable trays and/or conduit is performed prior to coordination with other trades, which interferes with work of other trades or operation and maintenance of the facility, make necessary changes to correct the condition at no additional cost to The Owner.
      - d. Prior to the final programming of any systems review with The Owner and the Design Professional all system features, functions, system operations, network mapping, system integrated responses and all related programming as required for the proper operation of the respective communications systems.
- 3.3 The Contractor shall maintain a complete set of current and up to date set of shop drawings and equipment submissions at the job site at all times. The Shop drawings and all other submissions shall be marked up to reflect all as-built conditions and shall be made available for review by the Design Professional at request.

### 3.4 EQUIPMENT INSTALLATION AND REQUIREMENTS

- A. All system equipment installations shall be in accordance with good engineering practices, NEC, local building codes, and all manufacturer's requirements. Cable terminations at all equipment locations shall comply with all state and local electrical codes. All wiring shall test free from all grounds, shorts, stray voltages, and EMI.
- B. Follow manufacturers' instructions for installing, components and adjusting all equipment and cabling. Submit one (1) copy of such instructions to The Owner and the Design Professional before installing any equipment. Provide an additional copy of such instructions at the equipment during any work on the equipment. Where no instructions are included with the equipment, follow accepted industry practices and workmanlike installation standards.
- C. Equipment location shall be as close as practical to locations as indicated on the contract drawings.
  - 1. Provide all equipment clearances in accordance with NEC requirements. Arrange equipment to facilitate unrestricted access for maintenance and service around all equipment, components and/or cable terminations.
- D. Inaccessible Equipment:
  - 1. Where The Owner and the Design Professional determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the project.
    - a. "Conveniently accessible" is defined as being capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

### 3.5 COMMUNICATIONS CABLING REQUIREMENTS

- A. Cabling shall be sized to support the appropriate communication system. All communications cable installations shall be in accordance with good engineering practices as established by the EIA, IEEE and the NEC. All cabling shall meet all state and local electrical codes.
  - 1. Contractors shall have the option to combine all cable home runs and conductors of same type and voltage "class" in accordance with NEC requirements unless specified elsewhere. Size all conduits and install all conductors in accordance with NEC requirements and manufacturers recommendations.
    - a. All communications cabling located above inaccessible ceilings, exposed ceilings, areas outside of tenant spaces shall be installed in conduit and routed to nearest cable tray or J-hook system in accessible ceiling areas.
    - b. All conduit shall run parallel and perpendicular to building column lines.
    - c. Cabling installed above hard ceiling spaces shall be installed in dedicated conduits.
    - d. No exposed cabling will be acceptable in finished or occupied spaces of the facility without approval by The Owner and the Design Professional.
    - e. Any communications system cabling installed exterior to the building and/or all cabling being routed from the facility to any remote location external to the project location shall utilize OSP rated fiber optic cable installed in conduit system.
  - 2. Do not install bruised, kinked, scored, deformed, abraded, or otherwise damaged cable. Do not splice cable between indicated terminations, taps, or junction points. Remove and discard cable where damaged during installation and replace it with new cable.

3. Ensure that all communications cabling supports (conduits, support grips, cable trays and cable termination panels) are fully installed before proceeding with cable installation.
4. At no time shall any cables be installed and left unsupported, nor shall cables be tie-wrapped to any other supporting structure in lieu of specified cable supports. Do not tie-wrap or permanently affix cable bundles to approved cable supports.
  - a. NOTE: Cable bundles shall not be cinched too tightly; all cable ties shall be hook-and-loop ("Velcro") tie-wraps only.
5. The Contractor shall not permit any communications cabling to lie unprotected on the floor at any time. If cables must be left on any floor, protect the cables so that they may not be walked on or have any material or equipment placed or rolled on top. Replace all damaged cables from demarcation to termination point; no splicing of damaged cables shall be permitted.
6. Maintain manufacturers recommended minimum bend radii of all cabling. Do not stretch, stress, tightly coil, bend or crimp cables. The Contractor shall keep all cabling out of the way of other trades during staging of any work. The contractor at the contractor's expense will replace all severely stressed or damaged cables, equipment, and materials as determined by the Owner and the Design Professional.

B. Unshielded Twisted Pair (UTP) Cable

1. Refer to specification section 271100 for material.
2. All data TCP/IP based copper network cabling shall be concealed above suspended ceilings, bundled, and independently supported to the building structure. All cabling bundles shall be plenum rated and shall not contain any AC carrying conductors or non-associated network cables.
  - a. All cabling shall be terminated onto patch panels matching the rating of the cable and installed in the 19" equipment racks/cabinets.
  - b. Copper station cabling may be run outside of conduits and above suspended ceilings only between the cable tray and the conduit wall stub-up.
  - c. All horizontal and backbone cable installed above accessible ceilings shall be installed on J-hooks, cable trays, dedicated conduits, or in cable chases and/or a combination thereof as indicated contract drawing or specified. In no case shall cable be supported on ceiling tiles, T-bars, or tie-wrapped to any conduit or pipes.
    - 1) Cables shall not be cinched too tightly; cable ties shall be VELCRO type tie-wraps only. Plastic wire ties shall not be accepted on any cabling.
    - 2) Horizontal network cabling shall not exceed a maximum distance of 295 feet from the associated communications room termination point to the furthest work area outlet termination point.
    - 3) Cable Support: Properly secure independently to the permanent building structure where not installed in raceway. Provide J-hooks at regular intervals appropriate to the cable and wire size. See drawing details for spacing requirements.
    - 4) Cables shall not lay loose on ceiling tiles or grids. Cables must be supported in all areas. Bridle rings and tie-wrapped supporting methods are not acceptable.
    - 5) Install all cabling parallel to building lines and follow building structure. Use cable support equipment/hardware recommended by the manufacturer and/or as herein specified.
    - 6) Provide all terminations, cross-connects, wire management, surge protectors, etc. For a complete and operational system.
    - 7) Any copper data communications system cabling installed exterior to the building and/or all cabling being routed from the facility to any remote location external to the project location shall be outside rated (OSP), unless specified otherwise. Outside plant cable shall not extend more than fifty (50)

feet into a building interior before terminating on surge protection and transitioning to indoor plenum cable.

C. Fiber Optic Cabling

1. Refer to specification section 271100 for material.
2. All fiber optic cabling shall be provided to meet the communications requirements for all network communications systems, at the minimum all fiber optic cabling shall be sized in accordance with the project documents.
3. All fiber optic cable connectors, terminations and patch panel ports shall be SC/APC-type.
4. All fiber optic cabling shall be a continuous segment from demarcation to termination point. Splices shall not be permitted except at transition points and for termination purposes.
5. All fiber optic cabling shall be installed above accessible ceilings wherever possible.
6. All fiber not installed in conduit or innerduct shall be supported to the building structure and shall be plenum rated armored type cabling installed on J-hooks or in cable trays or shall be standard type fiber optic cable which shall be installed in dedicated conduits.
7. Installation of all fiber optic cabling shall be in accordance with all guidelines established by the product manufacturer and all referenced industry standards.
8. Where fiber cable segments are installed in conduits, special care shall be taken to avoid damage to the cable.
  - a. While under pulling tension, the cable shall not be bent into a curve with a radius of less than twenty (20) times the cable diameter, or no less than manufacturers minimum.
  - b. Pulling tension shall not exceed manufacturer's recommended maximum tensile load. Contractor shall utilize a winch with tension control, or a "break-away" link designed to break away at or below the recommended maximum pulling tension.
  - c. Use methods and lubricating compounds on cables and wires to prevent damage to material and products during pulling-in. Provide compounds that are not injurious to the cable and wire jackets that do not harden or become adhesive.
9. J-hooks supporting fiber optic cabling shall not exceed a maximum of 2 armored fiber cables per 2" J-hook, or 4 per 4" J-hook.
10. Provide a minimum of twenty (20) feet of slack at each end of each fiber optic cable install. Slack shall be neatly bundled in a "figure-8" style loop mechanically secured independent of other systems.
11. All exterior fiber optic cabling shall be rated for exterior outside plant (OSP) applications and installed in dedicated inner-duct conduit system and routed in the exterior conduit ducts in accordance with the requirements of the contract documents. Outside plant cable shall not extend more than fifty (50) feet into a building interior before terminating and transitioning to plenum indoor fiber optic cable.
12. Fiber optic cabling shall be provided as the primary media for any exterior network components installed remote to building, as well as all network communications links for all backbone communications.
  - a. The contractor shall be responsible for the determination of actual segment lengths. Actual quantities will be calculated by the routing as indicated on the contract drawings and/or in the field based on existing conditions.
13. All splices shall be fusion type. Mechanical splices shall not be acceptable except for termination purposes.
14. Refer to related specification sections for additional information related to cabling types, sizes and testing requirements.

D. Environmental Conditions:

1. Systems, components, devices materials and equipment shall be capable of withstanding the environmental conditions of the space without mechanical or electrical damage or degradation of operating capabilities or performance.
  - a. Interior, Controlled Environment: System components, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient conditions of 2 to 50 deg C (36 to 122 deg F) dry bulb and 20 to 90 percent relative humidity, non-condensing and shall utilize NEMA 250, Type 1 enclosures.
  - b. Interior, Uncontrolled Environment: System components installed in non-temperature-controlled interior environments shall be rated for continuous operation in ambient conditions of -18 to 50 deg C (0 to 122 deg F) dry bulb and 20 to 90 percent relative humidity, non-condensing and shall utilize NEMA 250, Type 4X enclosures.
  - c. Exterior Environment: System components, conduits and back boxes installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of -34 to 50 deg C (-30 to 122 deg F) dry bulb and 20 to 90 percent relative humidity, condensing. Rated for continuous operation where exposed to rain as specified in NEMA 250, winds up to 137 km/h (85 mph) and snow cover up to 610 mm (24 in) thick shall utilize NEMA 250, Type 4X enclosures.
  - d. Hazardous Environment: System components, conduits and back boxes located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
  - e. Corrosive Environment: System components, conduits and back boxes subjected to corrosive fumes, vapors, and wind-driven salt spray in coastal zones, shall utilize NEMA 250, Type 4X enclosures.
  - f. Submersible Environment: System components, conduits and back-boxes subjected to prolonged submersion in water, shall utilize NEMA 250, Type 6P enclosures.
  - g. Areas where equipment and devices may be subject to damage by the general population shall be installed in vandal resistant enclosures; all fire alarm system and related devices shall be provided with wire guards.
  - h. Console: All console equipment shall, unless noted otherwise, be rated for continuous operation under ambient environmental conditions of 15.6 to 29.4 deg C (60 to 85 deg F) and a relative humidity of 20 to 80 percent.

E. Conduits/Raceway/Cable Trays:

1. Provide conduit and raceway systems for all communications networks as indicated below. Refer to all related specification sections for additional conduit and raceway information.
  - a. Accessible suspended ceilings: Provide conduit stub-up from each outlet location to space above ceiling. All conduit stub-up shall include nylon bushing at exposed edge of conduit for protection of all cabling
  - b. Exposed structure: Provide conduit run from each drop to a height of 12 feet to cable tray or J-hooks where provided.
  - c. Vertical Wire runway shall be installed in dedicated conduits and shall be supported any/all risers between floors in closets or accessible locations; in no case shall any cable risers be unsupported.
  - d. Cables entering all communications equipment rooms shall be supported with Cable tray from entrance to rack/cabinet location as indicated on the contract drawings and/or herein specified.
  - e. Wire basket cable tray system shall be provided in all corridors as indicated on the contract drawings and installed as herein specified.
2. All conduits/raceways shall be concealed and shall be installed above accessible finished ceilings and/or in walls. Any conduits/raceways installed in areas requiring installation to

be exposed, shall be installed tight to ceilings and at right angles to walls/building lines and shall not obstruct any access hatches, equipment service panels, lighting or other equipment and/or devices. No exposed conduits/raceways shall be installed without prior approval of The Owner and the Design Professional.

- a. Where conduits cannot be concealed above ceilings or in walls and must be installed in finished or occupied areas of the building, all conduits shall be finished wire-mold type raceways or approved equal. Finished wire-mold type raceways shall not be installed without prior approval in writing by The Owner and the Design Professional.
- b. Where any equipment and/or junction boxes are installed above non-accessible finished ceilings, the contractor shall provide access hatches listed for the intended application. Access hatches shall be located so that service access to the equipment and/or junction boxes is unimpeded.
  - 1) Access hatches shall not obstruct any equipment, service panels, lighting equipment, devices, or any architectural elements of the ceiling. At the time of submittals, the contractor shall submit all proposed access hatch locations for review by the Design Professional.
- c. All conduits/raceways shall be supported in accordance with NEC requirements and shall be affixed in such a manner that tampering and/or removal without the use of specialized tools shall be prevented.
- d. All conduits/raceways shall be installed in a manner that prevents tampering or removal when installed in areas exposed to the general population.
  - 1) Provide tamper-resistant installation utilizing "torx with peg" security-fastening devices for all conduits/raceways, equipment, devices, and appurtenances in all areas accessible to the general population and/or areas subjected to tampering or vandalism.
- e. Interior raceways shall be a minimum 1 inch unless otherwise noted. Exterior raceways shall be a minimum 1 1/4-inch. Size all raceways and install conductors in accordance with NEC requirements. Fill ratio shall not exceed 40 percent for indoor or exterior raceways.
  - 1) EMT conduit with compression fittings and/or MC cabling may be utilized in all inaccessible ceiling areas unless otherwise restricted by code.
  - 2) Threaded Rigid metal conduit shall be used on all exterior applications, stub-ups and all interior areas where concealed conduit requirements cannot be met and are exposed to tampering or damage by the general population.
    - a) All areas considered being of high risk due to the nature of the occupancy or the need to protect and maintain the integrity of the cabling shall be installed in rigid threaded conduits.
- f. Conduits shall be continuous. Conduit runs shall not exceed two (2) 90 degree bends and/or 100 feet without a pull/junction box.
- g. All conduits and pull/junction boxes shall be concealed in walls or ceilings unless otherwise noted.
- h. Conduits shall be connected to pull/junction boxes with set screw connectors and nylon screw on bushings.
- i. Conduit inside bend radius for 2" conduits or less shall be 6 times the internal diameter. Conduit inside bend radius for sizes over 2" shall be 10 times the internal diameter. The use of condulets (lb's) is prohibited.
- j. Pull/junction boxes shall not be used in lieu of a bend.

- k. Firestop all annular space around conduits at through-wall and through-floor penetrations match the rating of the penetrated wall and floor.
  - l. Field coordinate installation and exact placement with all trades.
  - m. Conduit expansion couplings shall be provided in all areas where expansion/contraction may occur to couple together two sections of a conduit run subject to longitudinal movement. The contractor shall refer to architectural drawings for exact locations of all building expansion joints. Conduit expansion couplings shall be consistent with the size the conduit being installed, shall be steel electrogalvanized, and shall meet all environmental and seismic conditions.
    - 1) Expansion couplings shall be weatherproof and approved for use indoors or outdoors without an external bonding jumper.
    - 2) Expansion couplings shall be UL Listed and approved for use in wet locations.
    - 3) Expansion couplings shall comply with UL 514B, CSA 22.2 No. 18 3-12, NEMA FB1.
  - n. Exterior raceways: PVC schedule 40 conduit at the minimum shall be utilized in all underground applications unless otherwise specified by related specification sections. The conduit shall be buried at a minimum 36" below grade. Warning flagging tape shall be buried 12" below grade to indicate the conduit routing location. Refer to related specification sections for additional information.
    - 1) All exterior conduits larger than 2" in diameter shall be provided with dedicated inner-duct conduit systems, segregated by network type (i.e. security, etc.) and shall include a minimum of one spare empty inner-duct per conduit.
    - 2) The Contractor shall have the option to utilize the same trench/routing location as other utilities. In no case shall any system conduits or duct banks be combined with other electrical utilities without providing the required separation between conduits as necessary to ensure the minimal transmission or conduction of any RF and/or EMI signals.
  - o. Outlet Boxes: shall be 4 x 4 x 2-1/8 inches deep with single gang reducer plate where required for all data outlet locations and single gang for wall-mounted telephone locations.
    - 1) All outlet boxes shall be provided with single or dual gang device mud-rings flush to finished wall as required based on type and configuration of outlet and type of wall construction.
    - 2) Use deep masonry boxes at masonry construction. T-Bar hangers or other appropriate mounting hardware shall be utilized to support boxes mounted in the ceiling.
3. Cable Trays (Communications Rooms): Provide cable trays in all communications rooms and closets for routing horizontal and vertical distribution and backbone communications cables. All cable trays shall be constructed of aluminum with two side rails and 9" rung spacing. Cable tray shall be complete with all materials, miscellaneous hardware and all appurtenances required for a complete cable distribution and support system.
- a. All cable tray widths shall be sized according to the total number of cables to be supported within the various trays plus an additional 100% spare capacity for future expansion capability. At the minimum all cable trays installed in communications rooms and closets shall be a minimum of 12" wide by 1.25" deep, unless otherwise noted.
  - b. Install cable tray in a manner ensuring that all circuits fully comply with all ANSI/TIA standards.



- 1) Maintain a minimum clearance of 24" between top of cable tray and ceiling structure or other equipment or raceway.
- 2) Maintain a minimum clearance of 12" between bottom of cable tray and top ceiling grid or other equipment or raceway.
- 3) Maintain a minimum clearance of 24" from all conduits or cables used for electrical power distribution.
- 4) Maintain a minimum clearance of 12" between bottom of cable tray and top of equipment racks and/or cabinets.
- 5) Maintain a minimum clearance of 24" from fluorescent lighting. All Pathways shall cross perpendicular to fluorescent lighting and electrical power cables or conduits.
- 6) Cable tray supports shall be attached to the structural ceiling or walls with hardware or other installation and support aids specifically designed for the cable tray and designed to support the cable tray's weight and required cable weight and volume.
- 7) Do not attach cable tray supports to ceiling support system or other mechanical support systems.
- 8) Load span criteria: Install tray supports in accordance with the load criteria of L/240.
- 9) Cable Trays shall be supported at 5-foot intervals.
- 10) All Cable trays shall be installed without burrs, sharp edges, or projections, which may damage cable insulation.
- 11) All lengths or sections of cable tray shall be bonded and grounded in accordance with NEC, EIA/TIA, IEEE.

- c. Follow manufacturers' instructions for installing, components and adjusting all equipment and cabling. Submit two (2) copies of such instructions to the Architect before installing any equipment. Provide a copy of such instructions at the equipment during any work on the equipment. Where no instructions are included with the equipment, follow accepted industry practices and workmanlike installation standards.

F. Penetrations of Walls and Floors:

1. All wall/floor penetrations are to be sleeved and fire stopped with approved fire stopping material or sealant as applicable for the type of penetration. Coordinate all cable and conduit penetrations of building with all affected trades. Refer to all related specification sections for additional wall/floor penetration requirements.
  - a. All penetrations of rated walls and floors shall be firestopped in accordance with the ASTM and NFPA standards. Refer to related specification sections for additional information.
  - b. Floor penetrations shall be sleeved with a minimum sleeve diameter of 4 inches. An additional penetration shall be provided for future use, sleeved, and capped and fire stopped as required.
  - c. Coordinate size of wall penetration with conduit size, number of conductors. Comply with all NEC requirements.
  - d. The fire rating of all penetrated walls, floors, and ceiling structures shall be strictly maintained. All penetrations shall be firestopped and sealed by the Contractor.
  - e. Install firestopping in open penetrations and in the annular space of penetrations for fire-rated barriers.
  - f. Installation of firestops shall be performed by an applicator/installer qualified and trained by the manufacturer. Installation shall be performed in strict accordance with manufacturer's detailed installation procedures.
  - g. Installation of all firestopping shall be in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer's recommendations, local fire and building authorities, and applicable codes and shall be installed in a manner acceptable to the authority having jurisdiction.

### 3.6 ELECTRICAL POWER DISTRIBUTION

- A. Refer to division 26 contract documents for circuiting information.
- B. Refer to specification section 271100 for UPS and PDU material.

### 3.7 TRANSIENT VOLTAGE SUPPRESSION

- A. Transient Voltage Surge Suppression: All cables and conductors extending beyond building façade, except nonconductive fiber optic cables, which serve as communications, control, or signaling circuits shall be protected against Transient Voltage surges and have Transient Voltage Surge Suppression (TVSS) protection.
  - 1. The TVSS device shall be UL listed in accordance with Standard TIA 497B installed at each end. Lighting and surge suppression shall be a multi-strike variety and include a fault indicator.
  - 2. Protection shall be furnished at the equipment and additional triple solid state surge protectors rated for the application on each wire line circuit shall be installed within 914.4 mm (3 ft) of the building cable entrance. Fuses shall not be acceptable for surge protection applications. All inputs and outputs shall be tested in both normal mode and common mode to verify there is no interference at the minimum surge suppression test shall meet the following criteria.
    - a. All system power supplies serving exterior system components or devices shall be provided with the appropriate transient surge suppression protection on both the line side as well as the load side.
      - 1) A 10-microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 volts and a peak current of 60 amperes shall be the minimum performance requirements. Provide surge suppression in accordance with all manufacturers' requirements.
      - 2) An 8-microsecond rise time by 20-microsecond pulse width waveform with a peak voltage of 1000 volts and a peak current of 500 amperes shall be the minimum performance requirements. Provide surge suppression in accordance with all manufacturers' requirements.
      - 3) Maximum series current: 2 AMPS. Provide units manufactured by Advanced Protection Technologies, model # TE/FA 10B or TE/FA 20B or approved equal.
      - 4) Operating Temperature and Humidity: -40 to 85 degrees C (-40 to 185 degrees) shall be the minimum performance requirements. Provide surge suppression in accordance with all manufacturers' requirements.

### 3.8 GROUNDING AND BONDING

- A. All electronic equipment, conduits, cable trays, racks/cabinets and cable shields shall be properly grounded and bonded in accordance with all requirements of EIA/TIA 607-A, NEC 250 and IEEE 1100. Where identified as applicable to the project, all equipment grounding and bonding shall be in accordance with all related specification sections and Motorola R56 Standards and Guidelines for Communications Sites.
  - 1. A Telecommunications Grounding System shall be installed in all communications equipment rooms. Grounding system shall provide equalization of the grounding potentials between the building power system and the telecommunications main grounding bus-bar (TMGB) as well as all telecommunications grounding bus-bars (TGB). Grounding bus-bar shall provide the diversion of electrical transients from the telecommunications cables and to provide a safety ground for all equipment racks/cabinets, conduits, cable trays and cable shields as well as providing the required coupling to cancel and/or reduce transients.

- a. The TMGB and each TGB shall be provided where indicated on the drawings and shall provide an effective bonding connection to the nearest approved building grounding electrode (e.g., structural steel) as well as to the local power distribution panel grounding system (e.g., ac branch circuit panel board's equipment grounding busbar).
  - 1) The minimum bonding shall be #6 AWG copper conductor connected to the TMGB and all TGB's. Connections shall be 2-hole NEMA type compression or exothermic welded connections.
2. All grounding connections shall provide the equalization of all grounding potentials between the building power system and the grounding terminations at the communications equipment in order to provide the diversion of electrical transients as well as providing the necessary coupling in order to cancel and/or reduce any voltage transients.
  - a. Equipment Grounding: Metallic structures, equipment racks, cabinets, and enclosures as well as all raceways, cable trays, junction boxes, outlet boxes, machine frames, and other conductive items shall be bonded and grounded.
  - b. Duct Banks and Manholes: Provide an insulated equipment grounding conductor in each duct containing any voltage conductors, sized per NEC except that minimum size shall be No. 2 AWG. Bond the equipment grounding conductors to the grounding bus, to all manhole hardware and ground rods, to the cable shielding grounding provisions for all cable splices, terminations, and equipment enclosures.
  - c. Metallic Fences equipped with communications equipment: Fences shall be grounded with a ground rod at each fixed gate post and at each corner post.
    - 1) Drive ground rods until the top is 300 mm (12 inches) below grade. Attach a No. 4 AWG copper conductor, by exothermic weld to the ground rods and extend underground to the immediate vicinity of fence post. Lace the conductor vertically into 300 mm (12 inches) of fence mesh and fasten by two approved bronze compression fittings, one to bond wire to post and the other to bond wire to fence.
    - 2) Each gate section shall be bonded to its gatepost by a 3 by 25 mm (1/8 by one inch) flexible braided copper strap and ground post clamps. Clamps shall be of the anti- electrolysis type.
3. All connections of grounding conductors to ground rods, bus bars, rebar, structural members, pipes, and fences, as well as splices of any ground conductors, shall be made by exothermic welds except where otherwise noted. All connections to bar lugs shall be exothermic weld or compression type connections. Bolted type connection of ground conductors may only be made where terminal lugs or blocks have been furnished and installed in equipment by the manufacturer.
  - a. Equipment grounding conductors shall be insulated stranded copper, except for sizes No. 10 AWG and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes No. 4 AWG and larger shall be permitted to be identified per the NEC.
    - 1) At the minimum bonding connection shall be a #6 AWG copper conductor. All grounding shall provide an effective bonding connection between the protected equipment to the nearest approved building grounding electrode (structural steel) as well as to the local power distribution panel grounding system (e.g., ac branch circuit panel board's equipment grounding busbar). All bonding and grounding connections shall be NEMA type compression or exothermic welded connections.

4. Refer to related specification sections for any additional grounding and bonding requirements.

### 3.9 EQUIPMENT IDENTIFICATION

- A. Identify all system controls, components and equipment cabinets using plastic laminate engraved ("limacoid") labels or approved equal. Firmly affix to the panel, device and/or component. Refer to all related specification sections for additional information.
  1. Nameplates shall be laminated black phenolic resin with a white core with engraved lettering, a minimum of 6 mm (1/4 inch) high. Secure nameplates with screws. Nameplates that are furnished by manufacturer as a standard catalog item or where other method of identification is herein specified. Dymo or Kroy tape adhesive-backed lettering shall not be acceptable.
  2. Color-code all junction boxes and enclosures per NEC recommendations. At the minimum provide all communications junction boxes as follows:
    - a. Color for Data/Telecommunications circuits - Yellow.
    - b. Color for Audio/Visual circuits – White
    - c. Letter all pull boxes and junction boxes located in service areas, tunnels, above accessible ceilings, and pipe chases with laminated black phenolic resin with a white core with engraved lettering, a minimum of 6 mm (1/4 inch) high. Secure nameplates with screws.
  3. Permanently label all cabling at both ends with self-adhering plastic labels.
    - a. Labeling: hand-written labels are not acceptable. All labels shall be machine printed on clear or opaque tape, stenciled onto adhesive labels, or type written onto adhesive labels. The font shall be at least one-eighth inch (1/8") in height, block characters, and legible.
      - 1) The text shall be of a color contrasting with the label such that it may be easily read. If labeling tape is utilized, the width of the tape shall not exceed 3/8," and the font color shall contrast with the background.
      - 2) All data patch panels shall exhibit data drop numbers, in sequential order, for all workstations served by the associated network equipment.
      - 3) Each fiber optic cable segment shall be labeled at each end with its respective communications network identifier.
      - 4) Warning Tags: At each location where the fiber cable is exposed to human intrusion, it shall be marked with warning tags. These tags shall be yellow or orange in color and shall contain the warning: "CAUTION FIBER OPTIC CABLE." The text shall be permanent, black, block characters, and at least 3/16" high.
        - a) A warning tag shall be permanently affixed to each exposed cable or bundle of cables, at intervals of not more than five (5) feet. Any section of exposed cable which is less than five (5) feet in length shall have at least one warning tag affixed to it.
  4. Provide typewritten circuit directories installed in 3-ring binders with transparent page protectors in each control and sub control cabinet and/or equipment rack.

### 3.10 WARRANTY

- A. Warrant material and workmanship for a period as specified in Division 1 of the contract documents and all related specification sections. The warranty period shall commence from the date the Contactor received written notification of final acceptance from the Owner's Representative. At the minimum the contractor shall provide warranty provisions:

1. Warrant the replacement of defective components/materials and/or correct defective work when given notice by the Owner's Representative during the warranty period.
    - a. At no time is the contractor to use the extra materials provided under the scope of this project to replace malfunctioning or damaged equipment and or components. The Contractor shall replace all malfunctioning or damaged equipment and or components with new. The repair and then reinstallation of malfunctioning or damaged equipment shall not be acceptable.
  2. Warranty excludes liability for consequential incidental, or special damages due to vandalism, misuse, or acts of God.
  3. On-site warranty response time by qualified technician shall be within 8 hours upon receipt of request from Owner.
  4. Warranty repairs shall be provided to the Owner at no cost. This shall include but not limited to replacement of all defective components/materials, all labor charges, all travel costs, and all vehicle charges.
  5. Response time shall be 7 days a week / 24 hours a day / 365 days a Year.
  6. Provide test, inspection, and service of each system on a semi-annual basis at six month intervals.
  7. Contractor must provide verification that they maintain their principle base of operation along with the personnel that will be responsible for providing service within 3 hours driving time to the project site. This tenet of the warranty shall remain in effect for the life of the warranty.
  8. All TCP/IP based communications systems cabling, and related appurtenances shall be provided with the manufacturers 25 year extended warranty in addition to all requirements above.
- B. The Contractor shall, as a condition of final payment, execute a written warranty certifying all contract requirements have been completed according to all requirements of the Contract Documents.
1. All system testing, commissioning, demonstration, and training shall be performed prior to final system acceptance. All defects or damages due to faulty materials or workmanship shall be replaced without delay, to the satisfaction of the Owner's Representative, at the Contractor's expense.
    - a. The contractor shall provide written documentation of test results and stating what was done to correct any deficiencies. The first inspection shall occur 90 calendar days after the acceptance date. The last inspection shall occur 30 calendar days prior to the end of the warranty.
    - b. The warranty period shall be extended until the last inspection and associated corrective actions are complete. Where any equipment and/or labor covered by Contractor's or manufacturer's warranty, has been replaced, due to failure, the warranty period for any replaced equipment or restored work shall be reinstated for a period equal to the original warranty period, and commencing with the date of completion of the replacement or restoration work.
  2. In the event any manufacturer customarily provides a warranty period greater than one (1) year, the Contractor's warranty shall be for the same duration for that component.

### 3.11 FIELD SERVICES AND TESTING

- A. Notify the Owner and the Design professional in writing, prior to the closing of any ceilings and ten (10) days advance of testing all system cabling to prevent delays in construction schedules.
  1. Test all cabling to confirm that no grounds, shorts, sneak currents, RFI and EMI conditions exist prior to start-up and commissioning of all, components, devices, equipment and/or systems.

- a. Before requesting a final inspection, the contractor shall perform a series of end to end installation performance tests. The contractor shall submit for approval by the Project Engineer and Design Professional all test procedures to be employed, test result forms, and timetable for testing all fiber optic and structured copper wiring.
- b. Acceptance of the simple test procedures discussed below is predicated on the contractor's use of the recommended products including but not limited to, fiber optic cable, category structured cable, cross-connect blocks, patch panels, and outlet devices specified and adherence to the inspection requirements and practices set forth. Acceptance of the completed installation will be evaluated in the context of each of these factors.

B. Balanced Twisted Pair Cable Testing

1. Minimum Test Parameter requirements for Category horizontal cabling.
  - a. Each wire/pair shall be tested at both ends for the following utilizing Contractor generated test results forms:
    - 1) Wire Map.
    - 2) Length.
    - 3) Insertion Loss.
    - 4) Near-end crosstalk (NEXT) loss.
    - 5) Power sum near-end crosstalk (PSNEXT).
    - 6) Equal-level far-end crosstalk (ELFEXT).
    - 7) Power sum equal-level far-end crosstalk (PSELFEXT).
    - 8) Return loss.
    - 9) Propagation delay.
    - 10) Delay Skew.
    - 11) Power Sum ACR.
  - b. All balanced twisted pair cable testing described herein shall exceed specified cabling transmission requirements of ANSI/TIA-568-C.
2. When errors are found, the source of each error shall be determined, corrected, and the cable re-tested. All defective components shall be replaced and retested. Defective components not corrected shall be reported to The Owner and the Design professional with explanations of the corrective actions attempted.
3. Test records shall be maintained using the approved test result forms. The form shall record closet number, riser pair number or outlet ID, outcome of test, indication of errors found (e.g., a, b, c, d, or e) cable length, re-test results after problem resolution and signature of the technician completing the tests.
4. Test results for each cable must be submitted with identification to match labels on all patch panel ports and 8 position modular jacks, and identification to match as- built drawings associated with that cable.
5. The Owner and the Design Professional shall observe and verify the accuracy of test results submitted.
6. Contractor shall submit both hardcopy printouts and electronic copy of all trace test results.

C. Fiber Optic Testing

1. Contractor shall test each fiber strand. The Owner and the Design Professional reserve the right to have a representative present during all or a portion of the testing process. If the Owner and the Design Professional elect to be present during testing, test results will only be acceptable when conducted in the presence of The Owner and the Design Professional.
2. Fiber optic cable: each fiber strand shall undergo bi-directional testing for signal attenuation losses.

- a. Test Equipment
    - 1) Optical Power Meter (OPM)
    - 2) Optical Time-Domain Reflectometer (OTDR)
  - b. Tests:
    - 1) All fiber strands shall be tested for attenuation using an Optical Power Meter in both directions at 1310 nm and 1550 nm.
    - 2) Test all fiber cable on the reel before installation, with a light source and an OTDR if necessary, to ensure fiber continuity and no factory defects.
3. Fiber Optic Testing Specifications
- a. All testing shall be performed by factory trained and certified personnel.
  - b. For all installed fiber optic cable EIA 455-171 Method D procedures will be adhered to (Bi-directionally).
  - c. Loss Limits:
    - 1) Connector loss shall not exceed 0.5 dB per connector pair
    - 2) Cable loss shall not exceed 1.0 dB per kilometer tested at 1310 nm and 1550 nm for premises/inside plant single mode fiber optic cable.
    - 3) Cable loss shall not exceed 0.5 dB per kilometer tested at 1310 nm and 1550 nm for outside plant single mode fiber optic cable.
    - 4) Fiber optic cable tests shall meet all other requirements as specified in TIA 568.C.
  - d. The contractor is responsible for obtaining minimum loss in fiber connections.
  - e. Pre-installation tests of Inter-plant fiber: pre-test each reel:
    - 1) Test each fiber strand of each reel for continuity with a light source.
    - 2) If a problem is found, test with an OTDR to determine the nature and location of the defect: Measure end-to end attenuation and the distance to a high attenuation point.
    - 3) If it is determined by Design Professional that the fiber is defective the contractor shall contact the manufacturer and provide a completely new fiber reel.
  - f. Tests for installed Inter-plant and Intra-plant fiber optic cable:
    - 1) Intra-plant and Inter-plant Single-mode: Bi-directional signal attenuation at 1310 and 1550 nm power meter.
    - 2) Inter-plant Single-mode: Bi-directional OTDR trace at 1310 and 1550 nm.  
OSP ONLY

NOTE: Obtain the actual index of refraction from the cable Manufacturer before testing.
  - g. Single-mode backbone links shall be tested as listed above and in accordance with ANSI/TIA-526-7, Method A.1, using not more than one reference jumper. All multimode backbone links shall be tested at 850 nm and 1300 nm in accordance with ANSI/TIA-526-14A, Method A.1, using not more than one reference jumper.
4. Power and Link Loss Budgets
- a. Contractor shall prepare and submit a fiber optic power and link loss budget report for all backbone fiber optic cabling links as part of shop drawing submissions.
  - b. The report shall include the Power Budget, Link Loss, and Power Margin utilizing

- industry-standard formulas for each backbone fiber optic link.
    - c. Submit all test reports for approval; an OTDR trace/signature report for every optical fiber strand and a fiber optic link attenuation record report for every cable by strand.
- D. Notify the Owner and the Design Professional in writing, ten (10) days advance of testing of all equipment and/or components to prevent delays in construction schedules.
  - 1. Perform all tests, as required, by authorities having jurisdiction throughout the facility.
  - 2. Test system for grounds to demonstrate that the ground resistance does not exceed the requirements of the National Electric Codes (NEC).
  - 3. Test all cabling to confirm that no grounds, shorts, sneak currents, RFI and EMI conditions exist prior to start-up and commissioning of all, components, devices, equipment and/or systems.
  - 4. Test all systems and components for proper function and operation; certify that all systems are in proper working operation in accordance with the Contract Documents prior to scheduling any system demonstrations.
  - 5. Test all fiber optic cabling as shown in Section C above.
  - 6. Testing of all communications systems shall be in the presence of The Owner and the Design Professional (if they so choose) as well as all appropriate representatives of the authorities having jurisdiction.
    - a. All completed communications systems shall be fully tested in accordance with all requirements of TIA. Upon completion of a successful testing, the contractor shall so certify in writing to The Owner and the Design Professional that all testing was completed, certified, and left in first-class operational condition, include all completed copper and fiber testing read-outs, certifications, and test reports.
    - b. The service of a competent, factory-trained engineer or technician authorized by the equipment manufacturer shall be provided to technically supervise installation and participate during initial system programming, start-up, final testing, assist in the final acceptance testing and demonstrations.
  - 7. Provide all testing, commissioning and certifications as specified by Division 01 and this specification section, as well as any manufacturer's recommendations or requirements.
- E. Tester Criteria
  - 1. General
    - a. Tester shall employ a modular platform with a minimum of a 2.0 Ghz processor.
    - b. Tester shall be Level IV/V ETL Verified.
    - c. Tester shall have hot swappable fiber modules and employ modules for:
      - 1) Multi-Mode capable of testing at 850 & 1300 nm
      - 2) Single Mode modules capable of testing at 1310 & 1550 nm
    - d. Tester shall have a current calibration date. If testing will go past calibration date, contractor shall have tester re-calibrated.
    - e. Tester shall be running current firmware.
    - f. Tester will be capable of performing 1,2 & 3 jumper set reference. One jumper is recommended.
    - g. Set reference shall be done with factory provided test reference cords (TRC's)
  - 2. Manufacturers:
    - a. Softing WX4500
    - b. Fluke Versiv
    - c. Or equivalent



3. The field-test instrument shall be within a 12-month calibration period.
4. Certification tester
  - a. Accuracy
    - 1) Level IV/V accuracy in accordance with ANSI/TIA-1152-A
    - 2) Independent verification of accuracy shall be provided
5. Permanent Link Adapters
  - a. RJ45 plug must meet the requirements for NEXT, FEXT and Return Loss in accordance with ANSI/TIA-568-C.2 Annex C
  - b. Contractor shall perform a successful set reference prior to the start of any project
  - c. Twisted pair Category 5e, 6, 6A, cords are not permitted as their performance degrades with use and can cause false Return Loss failures
6. Results Storage
  - a. Must be capable of storing > 5000 results for all measurements.
7. PC Software
  - a. eXport or LinkWare PC
8. Reporting:
  - a. Tester shall be capable of exporting raw data files in native format.
  - b. Reporting Software shall be capable of producing
    - 1) Detailed Fiber Certification reports in .PDF format
    - 2) Summary fiber reports in .PDF
    - 3) Fiber reports in CSV format.

### 3.12 TRAINING

- A. In addition to all demonstration and training as specified by Division 01 specification section and all related Division 27 specification sections, system demonstrations and training shall be provided in accordance with all requirements of this section.
  1. Prior to acceptance of the work, the System Integrator shall demonstrate to The Owner and the Design Professional, all systems and sub-systems all features and functions of each system and shall instruct The Owner's Representatives in the proper operation, event sequences, programming and maintenance of all systems and sub-systems.
  2. The ICTI shall furnish the necessary trained personnel to perform all demonstrations and instructions and arrange to have the manufacturer's representatives present to assist with the demonstrations.
  3. Training time shall include, as a minimum, the total time determined by the sum of the times per system as specified in this and related specification sections, for performing the prescribed demonstrations/training. Refer to related specification sections for additional training requirements.
    - a. Allow a minimum of 16 hours' time for each system provided for performing the prescribed demonstrations/training.
  4. Provide operation, parts and maintenance manuals defining operation and troubleshooting methods of all systems and review with The Owner's User/Operators as part of training demonstrations.

5. Provide detailed video recordings in high quality digitally formatted media of all demonstration and training of all systems and system operations.
  - a. Utilize remote microphones as may be required to ensure high quality audio of the recorded demonstrations.
  - b. Permanently and professionally label all recorded materials and provide self-sealing plastic cases.

B. Inspections

1. At the completion of the project and prior to final acceptance of the Work, provide evidence of final inspections and approvals to The Owner and the Design Professional, in accordance with all requirements of the Contract Documents as well as required by the authorities having jurisdiction.

END OF SECTION

## SECTION 271100

### NETWORK COMMUNICATIONS SYSTEMS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. Related Sections:

1. Division 07 – Through-penetration Firestop Systems
2. Division 26 – Common Work Results for Electrical
3. Division 26 – Low Voltage Electrical Power Conductors and Cables
4. Division 26 – Grounding and Bonding for Electrical Systems
5. Division 26 – Hangers and Supports for Electrical Systems
6. Division 26 – Raceways and Boxes for Electrical Systems
7. Division 26 – Identification for Electrical Systems
8. Division 27 – General Requirements for Telecommunications
9. Division 27 – Common Work Elements for Communications Systems
10. Division 27 – Network Communications Systems
11. Division 27 – Two-Way Communications System
12. Division 27 – Audiovisual Systems
13. Division 27 – Nurse Call/Code Blue
14. Division 28 – Common Work Elements for Electronic Safety and Security
15. Division 28 – Physical Electronic Safety and Security
16. Division 28 – Video Surveillance System

C. Reference Symbols:

1. All device symbols are defined by the appropriate symbol schedules. Because of the scale of the drawings, symbols are shown on drawings as close as possible to the mounting location.
  - a. Contractor shall coordinate exact locations with all architectural drawings, site plans, reflected ceiling plans, furniture plans, mechanical and electrical drawings as well as all affected trades prior to submittal of any shop drawings.

D. Abbreviations:

1. Refer to Specification Section 270500 for additional information.

E. Definitions:

1. Refer to Specification Section 270500 for additional information.

##### 1.2 SUMMARY

A. The intent of this specification is to establish a standard of quality, overall system configuration and equipment requirements for the installation of a new structured cabling system and audio/visual equipment in support of a facility TCP/IP network and specified Audio/Visual systems. The contractor shall be responsible for providing all design, installation, programming,

commissioning, testing and certifications as necessary to provide complete infrastructure to support all TCP/IP telecommunications networks in accordance with the Contract Drawings and/or as herein specified.

- B. All communications network cabling for TCP/IP-based Security systems as specified in Division 28 shall also meet the requirements of this section.
  - 1. The installation, performance, features, functions, software, and programming criteria as specified herein as well as all related specification sections have been designed to offer the maximum system efficiency ease of operation, occupant safety and the protection of equipment as recommended by the design Professional.
    - a. Any deviations from the specified criteria shall be documented, reviewed, and agreed to in writing by The Owner and the Design Professional prior to submission of bids. Refer to Division 01, Division 28, and all related Division 27 specification section for product substitutions.
  - 2. It is the responsibility of the contractor to ensure that the installed system meets or exceeds every standard set forth in these specifications. The contractor shall provide all cabling, communications outlets, conduits, system components, termination equipment, racks/cabinets, emergency electrical power, software, programming, and all appurtenances as well as all necessary testing, commissioning and certifications as required to provide a complete and fully operational TCP/IP based network, whether such items are specifically included in this section or not.
- C. The contractor shall furnish all labor, equipment, materials, testing, commissioning, programming, and certification in connection with the installation of a complete premises communications network system as indicated on the drawings and as herein specified.
  - 1. The systems shall be complete with all equipment as indicated on the contract drawings and/or described herein.
    - a. The systems shall include at the minimum but not limited to the following:
      - 1) Plenum rated cabling
      - 2) Fiber Optic Cabling (Network Backbone)
      - 3) Coaxial Cabling (MATV/CATV distribution)
      - 4) Conduit/Duct/Raceway/Cable Tray Systems
      - 5) Distribution/Termination Patch Panels
      - 6) Equipment Racks/Cabinets
      - 7) Communications Outlets/Jacks
      - 8) Equipment bonding and grounding
- D. The contractor and all sub-contractors for this work shall have read all of the General Conditions, Special Requirements, General Requirements and all applicable related specification sections and in the execution of all work shall be bound by all of the conditions and requirements therein.
- E. Prior to the submission of the Bid, any discrepancies or inconsistencies noted within these specifications and/or the project drawings shall be brought to the immediate attention of The Owner and the Design Professional.
  - 1. Project specifications and drawings may not deal individually with every component, control, device, or appurtenance, which may be required to produce the specified system configuration, and/or as necessary to meet the equipment and cabling requirements.

Coordinate all integration requirements with The Owner and the Design Professional and all appropriate systems providers.

2. Because of the scale of the drawings, symbols are shown on drawings as close as possible to the mounting location. The contractor shall coordinate the installation of all cabling, materials, equipment, devices, jacks, cable trays and conduits with all affected trades and document all coordination at the time of shop drawing submittals.

- F. This contractor shall assume total responsibility for coordinating all inter-building wiring, any common carrier provided network equipment, and/or The Owner provided equipment as it relates to the operation of these systems.

### 1.3 SCOPE OF WORK

- A. The contractor shall furnish all labor, equipment, materials, cabling, and the performance of all testing, commissioning, and certification in connection with the installation of a complete premises TCP/IP-based communications network structured cabling system and specified audio/visual systems in accordance with all requirements of the project drawings and/or as herein specified.

1. Provide and install all equipment described herein, including, but not limited to all, jacks/outlets, Category-6 cabling, fiber optic cabling, coaxial cabling, patch panels, distribution hardware, and patch cables as well as all conduits, outlet boxes and appurtenances necessary to provide complete and fully operating network communications structured cabling system.
2. Provide and install all equipment described herein, including, but not limited to all, video displays, projectors, video signal encoders, audio equipment and video processing equipment.

- B. Communications Systems Design Requirements:

1. Provide a complete operational communications network infrastructure including but not limited to all cabling, jacks, cabling distribution and termination components as indicated on the contract drawings and as herein specified.
  - a. All horizontal network connections shall utilize copper cabling and hardware for distribution to all control equipment as indicated on the contract drawings. All horizontal cabling shall be bundled and routed through the facility on "J" hooks sized to support the network cabling requirements and shall terminate on Category-6 patch panels in the communications equipment enclosures.
    - 1) NOTE: Cables shall not be cinched too tightly; cable ties at patch panel locations shall be hook-and-loop (VELCRO) type tie-wraps only. Plastic wire ties shall not be accepted on any cabling.
  - b. All communications cabling shall be terminated at both ends of the permanent link at all equipment locations, fiber optic, coaxial and patch panels.
  - c. The Contractor is responsible for the installation of the entire network communications infrastructure: including all workmanship, standards of quality, adherence to the contract documents, certification testing, as-built documentation, labeling, and final warranty in relationship to the performance and installation of the structured cabling systems in accordance with the contract drawings and/or as herein specified.

- C. Backbone Performance Requirements:

1. The intended function of the communications network is to transmit data communications signals from a central location to several individual data drop locations. Upon completion of the work in accordance with the contract documents, the system shall be capable of transmitting data signals at a rate of 1000 Mbps minimum over Category-6 cable and a minimum of 10Gbps over single-mode fiber optic cables based upon the transmitting distance, laser attenuation and number of links.
  - a. Single-mode OS2 8.3/125 micron (nominal) optical fiber cable shall be capable of transmitting signals at both 1310 and 1550 nm capable of providing a nominal 5km @ 1GBPS @1000 Base LX and nominal 10km @ 10GBPS @10GBASE-LX4 transmission rates.
  - b. All fiber optic cable shall be terminated on SC/APC-type connectors and ports.
2. The Contractor must certify in writing that the structured cabling system(s) are installed in accordance to the project documents, the referenced standards as well as all manufacturer requirements.
3. In addition, the contractor shall provide in writing all extended manufacturers' warranties for matching compatibility of the structured cabling system as well as all as-built drawings and field test reports for both the fiber and copper cabling systems before The Owner and the Design Professional will accept the installation.

#### 1.4 SUBMITTALS

- A. Refer to Specification Section 270500 for additional information.

#### 1.5 RECORD DOCUMENTS

- A. Provide Owner with complete set of record drawings in accordance with the requirements of Section 270500.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. Manufacturers listed as acceptable or equal shall not negate the contractor's responsibility for providing all systems in accordance with all functions and performance requirements of the Contract Documents.
- B. Where manufacturer and/or model numbers reference specific system components in this specification, it is to establish the performance requirements and quality of the systems and components only.
  1. It is in no way an inference that the referenced model numbers are the manufacturer's current product and are the only acceptable components for this project unless specifically referenced as "no substitutions."
  2. Contractor shall provide the manufacturers' most current product that shall meet and/or exceed the specified performance and features of all data, and telecommunications equipment and/or systems.
  3. Equivalent UL- listed equipment may be substituted for the approved manufacturers in accordance with all requirements of Division 01 specification section titled "Substitutions" and/or General Conditions to the Construction Contract and where approved equal is referenced in the specific specification section.
    - a. Where systems and/or components are referenced as "no substitutions," the specific system and/or components shall be provided.

- b. All substitutions shall comply with all requirements as specified in related specification sections and all system performance standards shall be maintained.
  - c. The contractor shall stipulate at the time of submission of bid the following information impacted by such a substitution.
    - 1) Any and all extensions in time impacted by the substitution.
    - 2) Any changes to the architectural or structural elements to the project.
    - 3) Differences in operation and/or performance from intended system criteria.
  - d. Failure to provide the required substitution information shall result in, without consideration, the immediate rejection of the substituted equipment and/or systems.
- C. Unless specified otherwise, the equipment furnished shall fall into six classes, and with the exception of Class 6, all of the material within a single class shall be the standard product of one manufacturer. Exceptions are noted as "Class Exempt." The six classes are as follows:
1. CLASS ONE-A (1A): Category-6 and Category-3 UTP, and Category-6 F/UTP copper cables (both horizontal and backbone), Category-6 patch cords, blocking kits, interconnection devices, connectors, wiring blocks, patch panels, and telecommunications outlets. Refer to applicable specification paragraphs for acceptable product manufacturers.
    - a. Note: All material covered in "Class One-A" shall conform to all manufacturers' cable/component matching connectivity requirements for the connection of all communications outlets, patch panels and cabling appurtenances provided as part of this project.
    - b. Other cabling systems meeting the listed performance and warranty requirements will be considered following compliance with all substitution requirements in accordance with Division 1 specification section titled "Substitutions."
  2. CLASS ONE-B (1B): Fiber Optic Cable (both horizontal and backbone), fiber optic jumpers, interconnection devices, connectors, wiring blocks, patch panels, and telecommunications outlets. Refer to applicable specification paragraphs for acceptable product manufacturers.
    - a. Note: All material covered in "Class One-B" shall conform to all manufacturers' cable/component matching connectivity requirements for the connection of all communications outlets, patch panels and cabling appurtenances provided as part of this project.
    - b. Other cabling systems meeting the listed performance and warranty requirements will be considered following compliance with all substitution requirements in accordance with Division 1 specification section titled "Substitutions."
  3. CLASS TWO: Inner-duct systems. All material covered in "Class Two" shall be equal in quality and performance to that manufactured by Carlon, Eastern Wire+Conduit, Endot or approved equal.
  4. CLASS THREE: Equipment racks, Wire Management Systems and Cable Trays. All material covered in "Class Three" shall be equal in quality and performance to that manufactured by Eaton (Formerly Cooper) B-Line, Chatsworth Products Inc., Legrand or approved equal.

5. CLASS FOUR: Communications Equipment Cabinets and Wire Management Panels. All material covered in "Class Four" shall be manufactured by Chatsworth Products Inc., Legrand (Ortronics), Middle Atlantic, or approved equal.
6. CLASS FIVE: Velcro wire ties/cable wraps, storage rings, labels, "D" rings (metal only), nuts, bolts, screws, and other miscellaneous and hardware.
7. CLASS SIX: Active network systems/Equipment/Hardware

- D. All equipment and peripheral devices shall be the standard product of a single manufacturer and shall display the manufacturer's name on each component.

## 2.2 COMMUNICATIONS NETWORK EQUIPMENT AND COMPONENTS

### A. Data Communications Outlets (Category 6)

1. Data Jacks/Faceplates: 4 pair, TIA/EIA-568B pinning, Category-6 compliant.
2. Modular Outlet Jacks & Faceplates: Standard 8-position, RJ-45 style, un-keyed, designed for 4-pair, 100 ohm balanced unshielded twisted pair (UTP) cable, 26-22 AWG solid or stranded conductors.
3. Acceptable manufacturers for this project shall include Commscope, Hubbell and Leviton.
4. Accessories: Category-6 Jacks or approved equal include a translucent stuffer cap for wire retention and to permit visual inspection. Jacks shall have attached wiring instruction labels to permit either T568A or T568B wiring configurations.

#### a. Modular Mounting Plates:

- 1) 2-Port: Leviton 42080-2WS or equal
- 2) 4-Port: Leviton 42080-4WS or equal
- 3) All mounting plates shall be supplied with mounting screws, clear screw covers and paper labels, and color matched screw covers. Office White – flush mounted with screws. Coordinate final color selection with architect.

### B. Equipment Cabinets/Patch Panels/Appurtenances

1. Provide wall-mounted communications equipment enclosures where indicated for all locations as indicated on the contract drawings. All wall-mounted enclosures shall meet the following requirements:
  - a. The enclosure shall be a UL listed; EIA compliant 19" horizontal distribution rack
  - b. Minimum (26) EIA standard 19" rack units (RU)
  - c. 30" minimum usable equipment mounting depth
  - d. Front mesh door with lock
  - e. Locking swing-open center section for front and rear access
  - f. Adjustable rack rail
  - g. Integrated cable management
  - h. Electrical knock-outs for conduits on rear section/pan
  - i. UPS sized for all equipment with floor-standing or rack-mounted options.
  - j. Horizontal Power Distribution Unit (PDU)
  - k. Position and install rack so as to permit full swing of rack away from wall without obstruction.
2. Provide floor-mounted communications open frame equipment racks where indicated for all locations as indicated on the contract drawings. All racks shall meet the following requirements:



- a. The rack shall be a UL listed; EIA compliant 19" horizontal distribution black in color.
  - b. 2-post with top plates and bottom plates for use with ½" anchoring hardware consisting of drop-in anchors, hex head bolts and fender washers on all mounting holes.
  - c. Double-sided vertical wire managers on both sides as indicated on the contract drawings.
  - d. Rack-mounted UPS sized for all equipment.
  - e. Vertical Power Distribution Unit (PDU)
  - f. Grounding busbar
3. Provide Fiber Optic Patch Panels (FOPP's) in sufficient quantities to support all fiber terminations as indicated on the contract drawings:
- a. IDF: Corning CCH-01U; MDF: Corning CCH-04U (or equals)
  - b. All housings: Provide with pigtailed cassettes, (6) duplex SC/APC ports per cassette (12 strands per panel), Single-Mode (part number CCH-CS12-D9-P00RE or equal). Provide cassettes in sufficient quantities to terminate all incoming fiber optic strands.
  - c. Furnish housings with minimum 20% spare cassette slot capacity for addition of future panels.
4. Provide Modular Category 6 and Category 6A copper patch panels in sufficient quantities to support all Category 6 and 6A cabling terminations as indicated on the contract drawings:
- a. Patch panels shall contain 110-block rear terminations for horizontal cabling and RJ-45 front connections for patch cords.
  - b. Patch Panels shall be 24-port TIA-568B wired Category 6 rated, Leviton # 69270-U24 or equal.
5. Patch Cables, Category 6, high performance: Leviton or equal (for back-of-house and amenity outlets only).
- a. Patch cables shall be provided in standard lengths of three (03), five (05), seven (07), ten (10) or (15) feet.
  - b. Provide Two (2) patch cables for each populated patch panel port; one in the communications room, and one in the work area/space.
    - 1) Patch cables in the communications room shall be of minimum length to permit installation without stress or strain at connection points to equipment, to permit relocation of cable to a different port on the same device, and to permit neat and workmanlike cable routing through cable management devices.
    - 2) Patch cables in the work area/workspace shall be (15) feet in length.
  - c. All patch cables shall be EIA/TIA-568B compliant and meet all product matching criteria.
  - d. All patch cables shall be provided with jacket colors as specified elsewhere in this section.
  - e. All Category 6 Patch cords must be provided by the same manufacturer as part of a certified structured cabling system and shall be color coordinated in accordance with cable and jack color coding requirements.

6. Network equipment cabinet wire management: Provide wire management devices in network equipment cabinets as shown on the drawings and described in these specifications:
  - a. 1 Rack Unit (RU) Horizontal Wire Manager: Leviton
  - b. 2 Rack Unit (RU) Horizontal Wire Manager: Leviton
  - c. Provide hook-and-loop (Velcro) tie-wraps as required for neat and tidy rear cable management.

C. Category 6 Cable – Data Network Communications

1. Category 6 Cable shall be “CAT6” cable tested to a minimum of 250Mhz, plenum-rated (CMP):
  - a. Berk-Tek: LANmark-1000 (or equal) for all non-residential unit cabling outlets
  - b. Berk-Tek: LANmark-10G2 (or equal) for wireless access points.
  - c. Berk-Tek: LANmark-6 (or equal) for all cabling within residential units
  - d. Berk-Tek: LANmark-1000 OSP (or equal) for all exterior outlets serving cameras.
  - e. Category 6 cable color coding requirements shall be as follows:
    - 1) Data – Blue
    - 2) Telephone – White
    - 3) Audiovisual – Yellow
    - 4) Security – Green

D. Fiber Optic Cable

1. Provide fiber cabling in accordance with the requirements of all related specification sections, at the minimum 12-strand single-mode cable unless otherwise indicated by the contract drawings.
  - a. Premise Distribution Interlocking-Armored Single-Mode – Corning #: 012ED8-T1301-A3.
2. Acceptable manufacturers shall include Corning, Commscope or Berk-Tek.
3. Fiber Optic Cable Terminations
  - a. All fiber optic cable shall be spliced on to splice-on connectors in the equipment racks.
  - b. All splices shall be fusion type. Mechanical splices shall not be acceptable.
  - c. All fiber optic connectors and patch panel ports shall be duplex SC/APC type.

E. Coaxial Cable (MATV/CATV Distribution)

1. Use RG-6/U cable for horizontal cable distribution drops to TV drop locations or as recommended by manufacturer.
2. Use RG-11/U cable for drops to TV locations or as recommended by manufacturer.
3. All coaxial cabling must be UL Listed, NEC type CL2 or CATV, Tri Shield, 75-Ohm cable installed in dedicated conduits.
4. Terminate all coaxial cable on coax patch panels in the equipment cabinet. At TV locations, terminate coaxial cable on single-gang wall pates with F-type connectors as shown on the contract drawings.

## 2.3 EQUIPMENT POWER DISTRIBUTION

### A. Uninterruptable Power Supply (UPS)

1. Provide minimum 6kVA UPS at the bottom of each rack/cabinet, unless otherwise specified.
2. UPS shall be high density, double-conversion on-line power protection with scalable runtime. Runtime shall be minimum 30 minutes at full load.
3. UPS shall include web-based network management card with SNMP.
4. Provide all mounting hardware and cables.
5. Include floor-standing and rack-mounted options.

### B. Rack Mounted Power Distribution Unit (PDU)

1. Provide rack mounted power distribution switch with surge protection for the distribution of all UPS connected power for each rack. The unit shall consist of a minimum of 12 AC power outlets, dual fed A/B circuiting, rated at 15 amps each and shall be equipped with integral surge protection circuitry (with bypass switch) capable of auto-resetting over-voltage and under-voltage protection.
2. The unit shall include a front mounted power switch (with guard) which shall control all 12 outlets. The four front mounted power outlets shall be spaced as transformer convenience outlets. The overall unit shall be single-height rack mountable chassis (1U) with three front panel indicator lights: (Power, Ground OK and Unsafe Voltage) and shall include front panel circuit breaker for protect or disconnect circuitry and dual 10-foot power cords for electrical power connectivity. The rear panel grounding lug shall be provided.
3. In addition to the above requirement the power distribution unit shall meet the following minimum requirements:
  - a. Integral Surge Protection Circuitry (with by-pass switch): Yes
  - b. Dual A/B Incoming Power Circuiting
  - c. Protect or Disconnect Circuitry: Yes
  - d. Thermal Fusing: Yes
  - e. Catastrophic Surge Circuit: Yes
  - f. Over/Under voltage Protection: Yes
  - g. Overvoltage Shutoff Gate: 144V  $\pm$ 11V
  - h. Under voltage Shutoff Gate: 84V  $\pm$ 6V
  - i. Single Pulse Energy Dissipation: 1350 Joules
  - j. Peak Impulse Current: 32,000A
  - k. EMI/RFI Noise Filtration: 50db (99.7%)
  - l. Line Voltage: 120VAC, 50/60Hz
  - m. Initial Clamping Level: 200V Peak, 141 Rms
  - n. UL 1449 Rating: 500V L-N, 500V L-G, 400V N-G
  - o. Protection Modes: L-N, L-G, N-G
  - p. Maximum Current Rating: 15A (1800W)
  - q. Response Time: 1-5 Nanoseconds
  - r. Plug Configuration: Straight
  - s. Number of Outlets: 12 (4 front, 8 rear)
  - t. Switched Outlets: All

## PART 3 – EXECUTION

### 3.1 EQUIPMENT PROTECTION

- A. Comply with all requirements of Specification Section 270500.

1. Examine all physical and environmental conditions, equipment and device locations, auxiliary system connectivity requirements impacting the installation of all network systems and report any unsatisfactory conditions in writing to The Owner and the Design Professional.

### 3.2 WORK PERFORMANCE

- A. In addition to all requirements as specified by Specification Section 270500 the network communications systems shall also be provided in accordance with the following requirements:

1. Prior to the final commissioning and/or programming of any network communications components, the Contractor shall provide a review with The Owner and the Design Professional addressing all network integrations, programming, and related operational connectivity.
  - a. Failure to provide this review and get final sign-off prior to programming shall result in any costs related to changes requested by The Owner and the Design Professional as not being charged to the project.

### 3.3 EQUIPMENT/CABLE INSTALLATION AND REQUIREMENTS

- A. In addition to all requirements as specified by Specification Section 270500 the network communications systems shall also be provided in accordance with the following requirements:

1. All system cabling shall be of the type, size and specification as required by all contract documents as well as stipulated by all codes and standards as specified by Specification Section 270500.
2. All network communications cabling shall be installed in accordance with the requirements of Specification Section 270500. All network cabling bundles shall not contain any AC carrying conductors or non-associated network communications cables within the cable raceways/conduits or cable bundles.
  - a. In addition, all structured cabling associated with the installation of any network communications system shall comply with all requirements of TIA standards for the proper installation, termination and testing of all fiber optic and UTP cabling.
  - b. Contractor shall provide all equipment, components, devices, hardware, equipment racks\cabinets, patch panels and all appurtenances necessary to provide fully operational network communications systems utilizing a UTP cabling topography. Coordinate all structured cabling with all trades and contractors prior to shop drawing submission.

### 3.4 ELECTRICAL POWER DISTRIBUTION

- A. Comply with all requirements of Specification Section 270500.

1. All system power supplies serving system components or devices on the exterior of the facility shall be provided with the appropriate transient surge and suppression protection on both the line side as well as the load side. Refer to specification section 27 05 00 for additional requirements.
2. Installation of all equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate trade contractors.

### 3.5 TRANSIENT VOLTAGE SUPPRESSION

- A. Comply with all requirements of Specification Section 270500.

3.6 GROUNDING AND BONDING

- A. Comply with all requirements of Specification Section 270500.

3.7 EQUIPMENT IDENTIFICATION

- A. Comply with all requirements of Specification Section 270500.

3.8 MAINTENANCE & SERVICE

- A. Comply with all requirements of Specification Section 270500.

3.9 WARRANTY

- A. Comply with all requirements of Specification Section 270500
- B. Provide all manufacturers extended cable warranties based on matching wire to component compatibility requirements. All cable warranties shall be in effect for a period of not less than 20 years.
- C. The warranty must include the following statements regarding the cabling system:
  - 1. "That all communications networks have been certified and will support and conform to ANSI/TIA-568-C specifications covering any current or future application which supports transmission over a properly constructed and horizontal cabling system premises network which meets the channel and/or basic link performance as described in ANSI/TIA-568-C."
  - 2. "That all communications networks are free from defects in material or faulty workmanship."

3.10 FIELD SERVICES

- A. Comply with all requirements of Specification Section 270500

3.11 TRAINING

- A. Comply with all requirements of Specification Section 270500.
- B. Documentation:
  - 1. Contractor shall provide documentation to include all test results and as-built drawings, test results shall be computer generated and shall include all trace reports indicating each pair tested in accordance with all requirements of Specification Section 270500.
    - a. One Hard Copy shall also be provided to The Owner and the Design Professional. Software for viewing the test results shall also be provided in the soft copy package.
- C. Final Acceptance
  - 1. Acceptance of all network communications systems, by The Owner and the Design Professional, shall be based on the results of testing, functionality, and the receipt of documentation. The testing, of all UTP cabling, fiber segments and all security and data network cables must meet the criteria established in the Specification Sections 270500.
  - 2. The Contractor must demonstrate to The Owner and the Design Professional that 1000 Mbps data signals can be successfully transmitted, bi-directionally, from the

communications room patch panels to and from a minimum of 10% of individual data drops on each floor, witness tested by The Owner and the Design Professional. The number of data drop locations to be tested shall be determined by The Owner and the Design Professional. With regard to documentation, all required documentation shall be submitted to The Owner and the Design Professional.

D. As-Built Documentation:

1. Contractor shall provide clean copies of the technology drawings depicting all as-built conditions for all data drop locations, cable routing and identification, patch panel, data switch port terminations, component layouts and all information as required by Division 01 specification section.

END OF SECTION

## SECTION 272100

### TWO-WAY COMMUNICATIONS SYSTEM

#### PART 1 GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.
- B. Related Specification Sections:
1. Division 07 – Through-penetration Firestop Systems
  2. Division 26 – Common Work Results for Electrical
  3. Division 26 – Low Voltage Electrical Power Conductors and Cables
  4. Division 26 – Grounding and Bonding for Electrical Systems
  5. Division 26 – Hangers and Supports for Electrical Systems
  6. Division 26 – Raceways and Boxes for Electrical Systems
  7. Division 26 – Identification for Electrical Systems
  8. Division 27 – General Requirements for Telecommunications
  9. Division 27 – Common Work Elements for Communications Systems
  10. Division 27 – Network Communications Systems
  11. Division 27 – Two-Way Communications System
  12. Division 27 – Audiovisual Systems
  13. Division 27 – Nurse Call/Code Blue
  14. Division 28 – Common Work Elements for Electronic Safety and Security
  15. Division 28 – Physical Electronic Safety and Security
  16. Division 28 – Video Surveillance System
- C. Reference Symbols:
1. All device symbols are defined by the appropriate symbol schedule on the symbols and abbreviations sheet in the telecommunications systems drawing package. Not all device symbols as indicated may be required for the project.
  2. Because of the scale of the drawings, symbols are shown on drawings as close as possible to the mounting location. Contractor shall coordinate exact locations with all drawings and affected trades prior to submittal of shop drawings.
    - a. The Contractor shall coordinate exact locations with all security and telecommunications drawings and site plan drawings as well as all affected trades prior to submittal of any shop drawings.
- D. Abbreviations:
1. Refer to Specification Section 270500 for additional information.
- E. Definitions:
1. Refer to Specification Section 270500 for additional information.

## 1.2 SUMMARY

- A. The Command Center is to be located at a central control point on the first floor or as determined by local Authority having Jurisdiction.
- B. The Command Center must include visual indicators to allow rescue personnel to know which Call Box needs assistance. The Command Center must allow rescue personnel to speak to each Call Box individually. The Command Center must include both a handset and speakerphone to communicate back to the Call Boxes.
- C. The emergency communication hardware shall comply with the Americans with Disabilities Act (ADA). The Call Boxes shall have the ability to be programmed with up to 2 emergency phone numbers (either both off-site or Base Station and one off-site). Upon activation of the emergency push button, a call will be automatically placed to the Command Center. If no one answers at the Command Center, the Call Box must dial a secondary location outside the building to activate two-way off-site person to person voice communications.
- D. The Elevator Landing and exit stair locations shall include 3 code required signs (Part #7050E/7087/7049).
- E. 1007.9 of the IBC 2009 requires if the exit signs are illuminated, Elevator Landing signs shall be illuminated (Part #7050E).
- F. 1007.9 of the IBC 2009 requires tactile signage complying with ICC A117.1 shall be located at each entrance to the area (Part #7087)
- G. 1007.11 of the IBC 2009 requires instructions on the use of the area under emergency conditions shall be posted next to each Call Box (Part #7049). The instructions shall include all of the following:
  - 1. Persons able to use the exit stairway do so as soon as possible unless they are assisting others.
  - 2. Information on planned availability of assistance in the use of stairs or supervised operation of elevators how to summon such assistance.
  - 3. Directions for use of the two-way communications system where provided.
- H. The installation, performance, features, functions, software, and programming as specified herein as well as all related specification sections have been designed to offer the maximum system efficiency ease of operation, occupant safety and the protection of equipment as recommended by the design Professional.
  - 1. Any deviations from the specified criteria shall be documented, reviewed, and agreed to in writing by the Architect and Design Professional prior to submission of bids.
  - 2. It shall be the responsibility of the Division 27 contractor to provide and install all systems, components, devices, power supplies, conduits, cabling, software, programming, commissioning, testing and all appurtenances as necessary to provide complete and fully operational ECS, whether specifically included in this section or not, and shall insure that the installed systems and components meet or exceed every standard set forth in these specifications.
- I. Prior to the submission of the Bid, any discrepancies or inconsistencies noted within these specifications and/or project drawings shall be brought to the immediate attention of the Design Professional.



1. All equipment symbols are shown on drawings as close as possible to their intended location. Contractor shall coordinate the installation of all equipment, devices, controls, cabling, and integration of any systems with all affected trades and system integrators. The Contractor shall document all coordination requirements at the time of shop drawing submissions.
  2. The Contract Drawings for this work are diagrammatic and intended to convey the extent, general arrangement, and locations of the work. Because of the scale of these drawings, certain items may not be shown.
    - a. The contractor shall include all equipment, materials, components, cabling, devices, controls, software, and all appurtenances as required by code, by manufacturers' recommendations, and all related Contract Documents as required to ensure the proper installation, operation and integration of all components, equipment, devices and/or systems.
- J. The Contract drawings and specifications may not deal individually with every part, control, device, software, or programming, which may be required to produce the equipment and/or system performance specified or as necessary for the installation and integration of all systems in accordance with all requirements of the Contract Documents and manufacturers' requirements.
1. The Contractor shall include all such items and components, as required, for the complete and operational installation of all system components as defined by the Contract Documents, whether or not specifically indicated and/or specified.
    - a. If installation of equipment, raceways, cable trays and/or conduit is performed prior to coordination with other trades, which interferes with work of other trades, make necessary changes to correct the condition at no additional cost to the Government.
    - b. The contractor shall be responsible for providing all wiring, connections to all equipment, circuits, and devices as well as all coordination and programming for the integration of all ancillary systems impacting the operation of ECS. Refer to the contract drawings and related specification sections for additional information.

### 1.3 REFERENCES

- A. All references to industry and trade association standards as well as all building codes are minimum installation requirements for this system. The codes, standards and agencies listed in specification section 270500 shall also form a part of this specification section and all work shall comply with the latest adopted standards.
1. The publications listed in specification section 270500 (including all amendments, addenda, revisions, supplement, and errata) shall form a part of this specification section to the extent referenced. The publications are referenced in the aforementioned specification section by the basic designation only.

### 1.4 SUBMITTALS

- A. In addition to all requirements as specified by Specification Section 270500, the emergency call system shall also be provided in accordance with the following requirements:
1. Provide a complete termination schedule of all emergency call station locations; indicate on the construction drawings station identifications corresponding with schedule.
  2. Provide all emergency call station installation and mounting details.

3. Submit product data sheets. Include operation manuals.
4. Wiring or shop diagrams detailing wiring schematics, cabling.
  - a. Wiring diagrams shall indicate all wiring for each emergency call station as well as all wiring interconnections between each device and all controls and/or associated equipment. In addition, all electrical power connections shall be indicated to all equipment requiring electrical power.

#### 1.5 QUALITY ASSURANCE

- A. In addition to all requirements as specified by Specification Section 270500 the emergency call system shall also be provided in accordance with the following requirements:
  1. All control equipment must have transient protection to comply with UL864 requirements. Where wiring and/or circuits leave the building, additional transient protection must be provided for each circuit. Devices must be UL listed under standard #497B (Isolated Loop Protectors).
  2. The contractor shall show satisfactory evidence, upon request, that the equipment supplier maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system. The supplier shall maintain at his facility the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being supplied.

#### 1.6 RECORD DOCUMENTS

- A. Comply with all requirements of specification section 270500.

#### 1.7 SOFTWARE AGREEMENT

- A. Comply with all requirements of specification section 270500.

#### 1.8 EXTRA MATERIAL

- A. In addition to all requirements as specified by specification Section 270500 the following extra materials shall be provided as part of this project:
  1. Provide two (2) ADA emergency call communications faceplates of each type of device provided as spare.
- B. All extra materials shall be delivered at the time of final acceptance of the system(s). At no time is the contractor to use the extra materials provided for this project to replace malfunctioning equipment and or components prior to final acceptance

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURED PRODUCTS

- A. Comply with all requirements of specification section 270500.

#### 2.2 MANUFACTURERS

- A. Acceptable manufacturers for this project, providing full compliance with this specification section and all requirements of specification Section 27 05 00 shall be as follows:

- B. Acceptable Manufacturers:
  - 1. RATH, or equal
- C. Manufacturers listed as acceptable shall not negate the contractor's responsibility for providing the emergency call system in accordance with all functions and performance requirements of this specification.

### 2.3 SYSTEM DESCRIPTION – COMMAND CENTER

- A. The contractor shall provide a fully operational enterprise-based Emergency Call System. The emergency call system shall consist of highly visible, vandal-resistant emergency call stations, with built-in ADA-compliant emergency phone unit. The units shall be either wall-mounted as indicated by the Contract drawings.
- B. The Command Center (2500 series) shall include both the Base Station and Distribution Module. The Base Station must have a powder coated steel housing (surface or flush mount) or be desk mounted, include a black handset with coil cord and be powered from the Distribution Module.
- C. Distribution Module must be a surface mount enclosure, include connections for the Call Boxes and power both the Base Station and 2400 series Call Boxes (Note: If a monitored system, use the 2100 series Call Boxes which require a separate power source). The Distribution Module shall be powered from 120vac power with a battery backup that provides power for a minimum of 4 hours (Rath RP7700104 for 12-36 Zone or RP7700105 for 56-Up Zone).
- D. The Call Boxes (2400 or 2100 series) must be in full compliance with ADA requirements. Call Boxes require a hands-free speakerphone with an LED to indicate status of call.
- E. The Call Boxes must allow the programming of a specific location message of the unit. This allows rescue personnel to know the location of the activated Call Box.
- F. The Call Boxes are to be located no higher than 48" front reach, or 54" side reach to the center of the button above ground level to ensure conformance with the ADA requirements.
- G. The Call Boxes must have a Braille faceplate to ensure conformance with the ADA requirements.
- H. The Command Center must provide an audible and visual indicator that a Call Box has been activated.
- I. The 120vac Power Supply model RP7700104 (12-36 Zone) or RP7700105 (56-Up Zone) must be capable of supplying power to the Distribution Module.
- J. Mounting
  - 1. The Command Center is to be mounted on a flat wall surface or a desktop.
  - 2. The Call Boxes are to be wall, surface or flush mounted.
- K. Electrical
  - 1. The Command Center and Call Boxes are to be powered by the Distribution Module.
  - 2. Distribution Module shall be powered by the Rath model RP7700104 or RP7700105 Power Supply. It shall require 120vac power and provide battery backup capable of

- providing a minimum of 4 hours of electrical backup in case of building power failure.
3. The Base Station shall connect to the Distribution Module with single wire pair (12-16 zone), two wire pairs (28-56 zone) and three wire pairs (76-up zone).
  4. Each Call Box shall connect to the Distribution Module with a single wire pair. Wire pairs shall be shielded if near any power runs, otherwise standard pair is acceptable. Wiring shall be Rath Custom Communication Cable RP7500094. If C1 2 hour fire rated cable is required, use Rath Communication Cable RP6600300M.
  5. System shall be in compliance with all state and local Electrical Codes.

L. Communications

1. The Call Boxes shall be an ADA compliant and vandal resistant speakerphone.
2. The Call Boxes shall be hands-free and be a push-button-once to talk system. Once the button has been pushed, the Call Box will call the Base Station. If no answer at the Base Station, it will automatically call a preprogrammed emergency number. The Call Box must be capable of being programmed with up to 2 emergency numbers (either both off-site or Base Station and one off-site).
3. The Call Box shall have location message capability. Call Box must have a minimum 18 second recordable message capability, programmable to play 1 or 2 times. Call Box shall notify called party of the location of the call upon being received at the emergency dispatch center.
4. The Call Box shall be capable of allowing the called party to replay the location message if necessary to ensure an understanding of the caller location.
5. If system is not attended to 24 hours a day, the Call Box must dial a secondary location outside the building to activate two-way off-site person to person voice communications.
6. Once a call has been made (button pushed), the call can only be terminated by the called party.
7. The Call Box must have a red LED that will light up upon push of the button. The light shall be a solid color when the Call Box is activated and will flash when call has been answered.
8. The Call Box must be capable of being programmed and reprogrammed on-site.
9. Standard Call Box features:
  - a. Two number programming (either both off-site or Base Station and one off-site).
  - b. Operating temperature of between -40°F to +150°F (-40° to + 65° C).
  - c. On-site programmable.
  - d. EEPROM memory to protect programming.

M. Signage

1. System shall consist of a minimum of one 120/277vac edge light sign (Part# 7050 or 7050E), a "location" and "instruction" sign (Part# 7049) to clearly indicate location of designated area. A tactile sign (Part# 7043/7044 or 7087) with raised letter and Braille shall be located at entrance to area.

N. Graphics

1. Command Center must include wording identifying the location of each Call Box and light an LED when a particular Call Box has been activated.
2. The Call Box wording must include "Emergency Phone", International Phone Symbol and raised Braille lettering.

O. Cabling

1. Cabling for two-way communication system shall meet the applicable requirements for pathway survivability. Cabling installation shall consist of one or more of the following:
  - a. 2-hour fire-rated circuit integrity (CI) cable – Rath Part # RP6600300M
  - b. 2-hour fire-rated cable system
  - c. 2-hour fire-rated enclosure or protected area

P. Warranty

1. The Command Center and Call Boxes shall be warranted for a period of three years.

2.4 EMERGENCY COMMUNICATIONS DEVICE

- A. The communications unit shall be a vandal resistant, high quality full duplex ADA compliant speakerphone, intercom, and paging device with advanced protocol support. The unit shall have a real time, non-open source, proprietary operating system and shall consist of a minimum of one 1.5 inch self-monitoring data button. The Bezel shall be labeled “EMERGENCY” in raised red lettering on white background with Braille symbols.

PART 3 – EXECUTION

3.1 EQUIPMENT PROTECTION

- A. Comply with all requirements of specification section 270500.

3.2 FIELD SERVICES

A. Testing

1. In addition to all requirements as specified by Specification Section 270500 the emergency call system shall also comply with the following requirements:
  - a. The service of a competent, factory-trained engineer or technician authorized by the equipment manufacturer shall be provided to technically supervise installation and participate during initial system programming, start-up, final testing, assist in the final acceptance testing and demonstrations.
  - b. At the minimum all acceptance testing, demonstrations and training shall include, but not be limited to the following:
    1. UPS Power and Secondary Power Distribution Capabilities
    2. Emergency Call System Monitoring/Control/Audio Functions.
    3. All programming and operational functions and features as herein specified and by the manufacturer.
    4. Include all training manuals, video instructions and hands-on demonstrations in the operation of all system components.

END OF SECTION

## SECTION 274100

### AUDIOVISUAL SYSTEMS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Division 1 Specifications, General and Supplemental Requirements apply to this section with additions and modifications specified herein.
- B. Instructions to Bidders, Bidding Forms, Forms of Agreement between Owner and Contractor, Contract Award Date, Starting and Completion Dates, Conditions of the Contract, Insurance Requirements, and other Owner Requirements will be furnished separately by the Owner. These documents, as well as any addenda issued, shall form a part of these Specifications, and this Contractor shall consult them in detail for instructions pertaining to his work.
- C. Each trade contractor shall receive all drawings and specification sections issued as part of the overall bid package. All contractors are to receive, review, and coordinate all of their work as shown or referenced on the other trade documents. All work shown or referenced on the other trade documents shall be included as part of the overall project scope for that particular discipline and trade.
- D. All other Division 27 Specifications.

##### 1.2 SUMMARY

- A. These specifications and accompanying drawings are intended to cover the furnishing of all labor, material, and equipment and superintendence of the Audiovisual (AV) and Paging Systems.
- B. It is the intent and purpose of this specification and accompanying drawings to cover and include each item, all materials, machinery, apparatus, and labor necessary to properly install, equip, adjust, and put into perfect operation the respective portions of the installations specified and to so interconnect the various items or sections of the work as to form a complete and properly operating whole.
- C. Any equipment, apparatus, machinery, material, and small items not mentioned in detail, and labor not hereinafter specifically mentioned, which may be found necessary to complete or perfect any portion of installation in a substantial manner, and in compliance with the requirements stated, implied or intended in these specifications shall be furnished without extra cost. This shall include all materials, devices, or methods peculiar to the machinery, equipment, apparatus, or systems furnished and installed as part of the AV Systems work.
- D. Drawings and this Section outline the performance requirements of the AV system. The Drawings are diagrammatic in nature and are meant to convey the performance intent of the system. Contractor shall develop a solution for each portion of the AV system and submit detailed shop drawings and product datasheets to indicate the proposed approach.
- E. The following major system components may be specified under this section:
  - 1. Signal Switching Transport
  - 2. Controllers and Control Interfaces
  - 3. IP encoders, decoders and network hardware to support AV systems
  - 4. Signal Processing Systems

5. Signal Recording and Storage
6. Cabling and Connectors
7. Racks and Connection Panels
8. Displays
9. Projectors and Projection Screens
10. Collaboration Systems and Appliances
11. Collaboration and Event Cameras
12. Wireless Presentation System
13. Wired and Wireless microphone system
14. Loudspeakers

### 1.3 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. No products have been identified to be furnished but not installed.

### 1.4 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- A. Products installed but not furnished includes all Owner Furnished Equipment (OFE) items which shall be configured and installed as part of a complete and working system as identified in the section summary.
- B. Refer to systems diagrams for information and functionality.
- C. All Owner Furnished Equipment, with the exception of Room PCs imaged with Owner's standard user desktop profile, shall be maintained as part of the labor portion of the system warrantee.
  1. Contractor shall assist in initial troubleshooting of Owner Furnished Equipment and if necessary, manage the equipment replacement process within the existing manufacturer warrantee period.
- D. New OFE Items
  1. Contractor shall take receipt of any new equipment procured by the Owner for this project, including Room PCs, Mini PCs, CATV Tuners, etc. as indicated in the Audiovisual Systems Equipment list.
    - a. If necessary for shop fabrication and testing, Contractor shall take receipt of equipment at Contractor's system staging location and transport the complete AV assemblies to the project site.

### 1.5 WORK NOT INCLUDED IN SCOPE

- A. Contractor shall coordinate with associated trades providing all work outside of this scope which may be necessary for a complete and working system.
- B. Work not included in scope includes:
  1. AV empty conduit, junction boxes, floor boxes, poke-thrus and other pathways for AV low voltage cabling unless otherwise specified in this section.
  2. Display in-wall boxes.
  3. Power receptacles supporting AV equipment.
  4. AV furniture including tables, lecterns, and credenzas
  5. Table hatches or table connectivity enclosures

- a. Contractor to coordinate and provide all hatch and enclosure faceplates, connectors, and cabling.
- 6. Architectural or event lighting control interfaces
  - a. Contractor to coordinate and provide all cabling between AV and lighting controllers.
- 7. Owner network horizontal cabling and ports between an AV device and the Owner's IDF/MDF/Network rack.
  - a. Contractor to coordinate and provide all patch cabling between Owner network drop termination points and AV devices including.
    - 1) Includes patch cabling run in glass front extrusions for use with room scheduling devices.
  - b. Contractor to coordinate and provide all network drops between AV devices or between an AV device and contractor provided network switch.

#### 1.6 PRICE PROCEDURES

##### A. Unit Pricing

- 1. Contractor shall provide unit and system pricing as part of their bid submission and maintain unit pricing throughout the contract term.

#### 1.7 LAWS, REGULATIONS AND CODES:

- A. Perform all work in strict compliance with all laws, regulations, and/or codes applying, including all Federal, State, and local codes and any other authority having jurisdiction. Wherever drawings or specifications conflict with such regulations they shall be made to conform, and approval of the Design Professional obtained on such changes as may be involved.
- B. All electrical and telecommunications work shall comply with the requirements of the National Electrical Code, latest accepted revision.

#### 1.8 PERMITS, FEES, AND CERTIFICATES OF APPROVAL:

- A. Unless stated otherwise in General Conditions or Division 1, obtain, and pay for all permits, fees, and licenses required, including those of utilities and Agencies. Provide copies to Design Professional in the quantity requested. "Fees" shall include connection charges construction costs, and other such charges by utility companies or service providers. Ascertain such charges during bidding period and include bid price.

#### 1.9 REFERENCES

- A. The publications list below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
- B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.
- C. Conflicts:



1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
2. Between referenced requirements and contract documents: Comply with the one establishing the more stringent requirements.

D. References:

1. General: The system shall comply with all applicable codes, ordinances and standards as interpreted and enforced by the local authority having jurisdiction.
2. Avixa (Audiovisual and Integrated Experience Association, previously InfoComm) standards including:
  - a. Display Image Size for 2D Content in Audiovisual Systems
  - b. Cable Labeling for Audiovisual Systems
  - c. Audio Coverage Uniformity in Listener Areas
  - d. Standard Guide for Audiovisual Systems Design and Coordination Processes
  - e. Projected Image System Contrast Ratio
  - f. Audiovisual Systems Energy Management
  - g. AV Systems Performance Verification
  - h. Audio, Video and Control Architectural Drawing Symbols Standard
  - i. Electronic Symbol Files - Audio, Video and Control Architectural Drawing Symbols
3. American Society for Testing and Materials (ASTM)
4. ANSI standards including:
  - a. ANSI/TIA/EIA-568-B.1 Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements
  - b. ANSI/TIA/EIA-568-B.3 Commercial Building Telecommunications Cabling Standard, Part 3: Optical Fiber Cabling Components Standard
  - c. ANSI/TIA/EIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
  - d. ANSI/TIA/EIA-606-A The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
  - e. J-STD-607-A Commercial Building Grounding and Bonding Requirements for Telecommunications
  - f. ANSI/TIA/EIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
  - g. ANSI/TIA/EIA-526-14A Measurement of Optical Power Loss of Installed Multimode Fiber Cable Plant
5. BICSI -- Telecommunications Distribution Methods Manual
6. BICSI -- Cabling Installation Manual
7. Underwriters Laboratories Listed, UL Certified
8. National Electrical Code Articles 770 and 800.
9. NFPA 780 - 2005 or newer.
10. RUS Standards (formerly REA)
11. Local State Uniform Fire Prevention and Building Code.
12. Local State Department of Labor Rules and Regulations
13. Local State Department of Health
14. Code of Federal Regulations (CFR) [Telecommunications] Title 47 Part 90
15. Code of Federal Regulations (CFR) [Telecommunications] Title 47 Part 15

## 1.10 DEFINITIONS

- A. The term "Furnish" shall mean to obtain and supply to the job site. The term "Install" shall generally mean to fix in position and connect for use. Where language indicates that one party or trade is to "install", and another is to "connect", the term "install" shall mean only to fix in position, and "connect" shall mean to make electrical connections. The term "Provide" shall mean to furnish and install.
- B. ANSI – American National Standards Institute
- C. AV – Audio / Visual, audiovisual, audio visual
- D. Avixa - Audiovisual and Integrated Experience Association, formerly InfoComm
- E. HTML – HyperText Markup Language
- F. IP – Internet Protocol
- G. ISO – International Organization for Standardization
- H. NEC – National Electrical Code
- I. NEMA – National Electrical Manufacturing Association
- J. SNMP – Simple Network Management Protocol
- K. TCP – Transmission Control Protocol
- L. TIA – Telecommunications Industry Association
- M. UL – Underwriters Laboratories
- N. VLAN – Virtual Local Area Network
- O. VoIP – Voice over Internet Protocol
- P. VPN – Virtual Private Network

## 1.11 RECORD DRAWINGS:

- A. During construction keep an accurate record of all deviations of the work as shown on the drawings and that which is actually installed.
- B. Secure from the Design Professional a complete set of prints of the AV drawings and note changes thereon. Make a complete record in a neat and accurate manner, of all changes and revisions to original design which exist in completed work, in the file format originally received.
- C. The cost of furnishing above drawing files and preparing these record drawings shall be borne by the Contractor. When all revisions showing the work as finally installed are made, the corrected prints and drawings files shall be submitted for review and approval by the Design Professional.
- D. Record drawings shall be delivered to Owner within 30 days after acceptance of completed project by Owner.

1.12 OPERATING INSTRUCTIONS:

- A. Provide to the Owner three bound copies of complete written instruction on the operation, care and maintenance of each piece of equipment and the installation as a whole. Include frequency of inspection, cleaning and adjusting and other attention as may be required in accordance with manufacturer's instructions. Material shall be manufacturer's brochures, catalog cuts, parts lists, wiring diagrams, etc. Also supply Owner with three complete sets of approved shop drawings.
- B. Furnish qualified personnel to instruct the Owner's personnel in the maintenance and operation of all equipment and systems. Instructing personnel shall remain on the job continuously during working hours until such instruction is complete, but not less than 16 hours.

1.13 PERFORMANCE REQUIREMENTS

- A. Provide a complete, fully functional installation of the AV and Paging System and associated components including:
  - 1. Engineering and installation services aligning to the published project schedule.
  - 2. Coordination with the Owner, Architect, Design Professionals, General Contractor and all associated trades.
  - 3. Creation, submission, and revision to the point of receiving approval of an AV Systems Submittals package.
  - 4. Equipment procurement.
  - 5. Equipment delivery to the site and removal of all trash.
  - 6. Provide all installation tools and materials necessary to complete all equipment installation tasks including ladders, scaffolding and lifts.
  - 7. Equipment installation.
  - 8. Systems setup, configuration, and commissioning.
  - 9. Systems demonstration to Owner and Design Professional.
  - 10. Remediation of any systems identified by Owner and Design Professional as not meeting published equipment specifications or the requirements as set out in this scope of work.
  - 11. As-built documentation.
  - 12. End User Training.
  - 13. AV Systems Warranty.
- B. Provide all equipment accessories, manuals, mounting hardware, remotes and other ancillary pieces furnished by the manufacturer but not required for installation.
- C. Provide all AV and paging low-voltage cabling, connectors, connector plates, patch bays and patch cables.
  - 1. Confirm cable types and verify required length of all installed and portable premanufactured cables and assemblies prior to order.
- D. Terminate and test all AV and paging low-voltage field connections.
  - 1. Provide all connectorized plates, connectors, cable labels and plate labels.
  - 2. Confirm finish of all plates and labels with Design Professionals.
- E. Install and configure Owner Furnished Equipment.
- F. Confirm color selection of all exposed AV equipment with Owner prior to order.

- G. Confirm required openings, recesses and mounting locations of all AV equipment to meet manufacturer requirements. Verify onsite prior to completion of wall framing and electrical rough-in.
- H. Contractor to include manufacturer onsite oversight labor including commissioning services and end user training for any systems which Contractor does not have staff with relevant manufacturer training and any available manufacturer certifications.
- I. Provision all video conferencing, wireless presentation and other collaboration hardware endpoints with Owner's network and collaboration system registration information.
- J. Coordinate AV equipment blocking requirements with the General Contractor prior to installing AV equipment.
  - 1. All wall or ceiling mounted equipment to be provided with hardware sized for a 5:1 safe working load limit.
  - 2. All ceiling mounted equipment to be provided with a safety cable or redundant support system attached to building structure and sized for the equipment by the equipment manufacturer.
- K. Install all AV and paging rack hardware including rack bases and wall supports.
  - 1. Confirm that all AV rack locations will allow proper clearances.
  - 2. Coordinate with the General Contractor location of all AV rack power receptacles, data jacks, CATV jacks and empty AV low voltage junction boxes.
  - 3. Confirm sufficient heat exhaust and cooling systems have been provided to meet systems demand loads.
  - 4. Request of the General Contractor a normally-closed fire alarm mute contact for all event systems as identified in the Audiovisual Drawings.
  - 5. Provide rack hardware, cable management hardware and rack accessories as necessary to meet rack and equipment manufacturer recommended configurations.
- L. Provide all necessary copper and fiber patch cables for making all device interconnections. Patch cable type and color shall be coordinated with the structured cabling package to match project standards.
- M. Provide an AV equipment network coordination submittal for Owner completion. Configure all AV equipment with the confirmed network settings and test operation on the Owner network.
- N. Loudspeakers
  - 1. Coordinate location of all wall and ceiling speaker systems including location of low voltage and power infrastructure.
  - 2. Review all ceiling speaker mounting conditions and provide ceiling speakers with a tile bridge or other relevant manufacturer support system.
  - 3. Where indicated in the specification, paint all exposed speaker grills with a custom color as confirmed by Owner.
- O. Furniture
  - 1. Coordinate with furniture providers all AV equipment installation requirements including cutout sizes, connector/plate openings, wiring openings, raceways, methods of affixing cables and equipment.

- a. All equipment and cabling shall be installed in a neat and professional manner with the intention of limiting visibility of supporting hardware and cabling.
  - b. All table cabling shall be secured to the table or hidden in a plinth, cloth wrap or articulating cable manager.
2. For all technical furniture provided under this scope of work, coordinate equipment layouts, and finishes with Owner and Design Professional prior to ordering.

P. Wireless Systems

1. Coordinate wireless frequency selection based on a site survey and relevant government agency requirements. Address any wireless channel conflicts prior to equipment ordering.
  - a. For meeting or event space wireless microphone and in-ear monitor systems, provide the Owner with a system capable of adjusting wireless frequency as necessary to maintain reliable system operation in the installed environment.
2. Coordinate placement of wireless antennas and provide antenna splitting, combining and amplification as necessary to operate within manufacturer required signal strength ranges.

Q. Control Systems

1. Coordinate with the General Contractor the location of all external system interfaces including lighting, shades, occupancy, BMS as required.
  - a. Provide cabling between AV controllers and external system interfaces.
2. Provide custom AV control system code development as necessary to operate all AV equipment user controls per specification.
  - a. Manage a control interface confirmation process with Owner and Design Professional as outlined in the AV submittal requirements.
3. Configure all digital signal processors, content management systems, scheduling systems and other processor-based platforms to optimize to the spaces and systems being served.

1.14 QUALITY ASSURANCE

A. Comply with the requirements of the following codes and/or standards:

1. ANSI.
2. ANSI.
3. UL.
4. NEMA.
5. NFPA.
6. NEC.
7. IBC 2009.
8. BICSI.
9. ANSI/TIA 568-D Series.
10. ANSI/TIA 569-E.
11. ANSI/TIA 606-C.
12. ANSI/TIA 607-D.

B. All packaged equipment shall be independently Third Party labeled as a system for its intended use by a Nationally Recognized Testing Laboratory (NRTL) in accordance with the OSHA Federal

Regulations 29CFR1910.303 and .399, as well as NFPA Pamphlet #70 and National Electric Code (NEC), Article 90-7.

- C. The contractor shall be certified by the manufacturer of the products, adhere to the engineering, installation and testing procedures, and utilize the authorized manufacturer components and distribution channels in provisioning this Project.
- D. All members of the installation team shall be certified by the manufacturer as having completed the necessary training to complete their part of the installation. Resumes of the entire team shall be provided along with documentation of completed training courses. Submit resume and copy of technician's license including:
  - 1. A Technical resume of the Contractor's Project Manager and Field Supervisor documenting a minimum of five (5) years of experience installing similar size projects.
  - 2. Matching documentation for any Sub-Contractor who will assist the Contractor in performance of this work.
- E. All hardware, software, firmware, and/or operating system requirements given are the minimum requirements. The Contractor's product shall meet or exceed these requirements. The product selected shall meet the operational, functional, and performance requirements specified herein. Additionally, due to the rapid advancement and antiquation of technology related products, the supplied product shall be the "contemporary technical equivalent" of that specified. "Contemporary technical equivalent" shall be based on a comparison of technology at the time of publication of specification to the technology at the time of the first product submittal. Final product approval is at the sole discretion of the Owner.
- F. Manufacturer: The manufacturing company selected shall have a minimum of five years of experience in producing the products.

#### 1.15 SUBMITTALS

- A. Contractor must receive approval from the Owner or Design Professional of a submittal before procuring equipment or performing services related to the submittal.
- B. All submittals shall be provided in electronic format.
  - 1. Provide one full size paper submittal if requested by Owner.
  - 2. Confirmation of the submittal schedule and submission format must be obtained by Owner prior to creating individual submissions.
- C. Revised submittals shall include clouding or other method to indicate revisions since the prior submission.
- D. Project Status Report
  - 1. A project status report shall be sent to the Owner and Design Professional weekly starting within two weeks of award. The project status report shall be used as the basis for Contractor coordination meetings and shall include:
    - a. Team member contact information
    - b. Project overall schedule
      - 1) Highlight changes to the schedule since last issuance
      - 2) Identify critical schedule items
      - 3) Identify opportunities to improve on the current schedule

- c. Action items from prior coordination meeting and status of each item
  - d. Installation schedule and status for each unique space or system in the project.
  - e. Outstanding Owner coordination items.
  - f. Outstanding Design Professional coordination items.
  - g. Change Order Status
  - h. Submittal Approval Status
  
- E. Within five business days of award, submit an installation schedule including major milestone dates for construction phasing based on overall project construction schedule (along with separate phases where applicable), system and device configuration, testing and training. Include the following milestones:
  - 1. Separate milestones for each submittal.
  - 2. Signage content and system configuration coordination session.
  - 3. Required date for receipt of all OFE equipment per project phase or equipment type.
  - 4. Required data for receipt of any Owner furnished signage content
  - 5. AV project manager onsite.
  - 6. Delivery of all Furnished but not Installed equipment to site
  - 7. Cable pulls start and complete
  - 8. Mount and speaker installation start and complete
  - 9. Equipment installation start and complete
  - 10. Systems configuration and testing start and complete
  - 11. Systems ready for checkout and punch list
  - 12. Owner training
  - 13. As-built submission
  
- F. Within 30 business days of award submit an AV infrastructure review memo confirming infrastructure shown on the AV, Architectural, Telecom, Mechanical and Electrical design packages meets AV equipment installation requirements or identifying specific adjustments necessary to support the specified AV equipment.
  - 1. Verify AV conduit sizing and pathways
  - 2. Verify architectural recesses and ADA clearances
  - 3. Verify data drops to support AV network connectivity
  - 4. Verify AV power receptacles and multi-discipline shared services device requirements (in-wall boxes, floor boxes, poke-thrus.
  - 5. Verify AV enclosure cooling/exhaust
  - 6. Verify ceiling device layouts and clearances, projector, and projection screen orientation
  
- G. Qualifications: The Contractor shall submit qualification data sheets for firms and persons as specified in the "Quality Assurance: section of this specification to demonstrate their capabilities and experience.
  
- H. Submit proposed product data sheets: The Contractor shall submit catalogue cut-sheets that include manufacturer, trade name, and complete model number for each product specified or selected for use in the project.
  - 1. Model number shall be highlighted to indicate exact selection per system type.
  - 2. Product data sheets shall be organized with separate folders per system type with a master equipment list broken into three sections:
    - a. System types and quantities of systems
    - b. Equipment and equipment quantities per system type
    - c. Master project equipment list and quantities

3. Confirm manufacturer master quote numbers and the accuracy of the master quotes against the specified equipment.
- I. Submit shop drawings detailing proposed system architecture and interconnectivity.
    1. All shop drawings sheets shall be sized to match the project architects drawing format.
    2. Shop drawings shall include the following drawing information.
      - a. Scaled floorplans indicating the area of work and room types.
      - b. Enlarged plans indicating equipment locations, mounting requirements, clearances, infrastructure requirements, and cable routing.
        - 1) Provide projector and projection screen throw distance calculations.
        - 2) Provide display elevations and sections.
        - 3) Identify any details which do not meet minimum ADA clearance requirements.
        - 4) Identify equipment centerline coordinated with furniture and main display wall.
      - c. Device details indicating mounting requirements for each unique equipment type in the project.
        - 1) All overhead equipment details must identify the safe working load and manufacturer provided safety hardware. Where a custom mounting detail is required using fabricated components or components provided by multiple manufacturers a structural detail, reviewed and stamped by a Structural Engineer license in the project state, must be provided.
        - 2) Copies of manufacturer cut sheet details shall not be considered sufficiently coordinated.
      - d. Rack elevations and mounting details with clearances and infrastructure requirements
      - e. System flow diagrams with cable labels and corresponding cable schedule indicating wiring interconnections between all AV devices and Owner's network.
      - f. Wiring termination details.
        - 1) Include cable labelling standards and materials
      - g. Panel details showing all prefabricated and custom connector panels, connector types, labels and required backbox.
      - h. Technical Furniture details indicating the location, required openings and cable management of all AV equipment in furniture and millwork regardless of what scope the furniture is provided under.
- J. Control Systems
  1. Owner or Design Professional approval of all Control Systems submittals is required prior to installation. Failure to secure approval shall not be grounds for project schedule delay or Contractor change order.
  2. Submit button panel layouts with labelling/engraving and sequence of operations.
  3. Submit audio DSP configuration files.
  4. Submit an initial and up to two revised set of touch panel user interface submittals.
    - a. Contractor shall lead a user interface review session with Owner and Design Professional prior to start of touch panel user interface design. Contractor shall



provide up to three design samples in advance of the user interface session for Owner and Design Professional review.

- b. User interface layouts shall follow the best practices laid out in the InfoComm *Dashboard for Controls*
- c. The overall user interface design process shall reflect the current draft Avixa UX 701.01 *User Experience Design for AV* recommendations
- d. User interfaces shall include the following basic features:
  - 1) Control of all local AV equipment addressable parameters required during the specified use cases.
  - 2) Call controls, transport controls, source selection, volume controls as appropriate.
  - 3) Standard controls formatted to match industry standard applications (knobs, sliders, buttons, interactive menus, etc.)
  - 4) A password protected advanced section allowing for control of individual device parameters (power, channel level controls, input selection, etc.)
  - 5) Utilize stock manufacturer pages and capabilities where possible. Custom scripting shall be avoided unless where required as part of this specification.

K. Network Coordination Submittal

- 1. Submit a detailed list of all network enabled AV devices detailing:
  - a. MAC address
  - b. IP Address (for Owner to complete)
  - c. Subnet (for Owner to complete)
  - d. Wired and Wireless VLans
  - e. DHCP requirement
  - f. Unique network requirements including firewall exceptions, port forwarding and Qos
- 2. Lead an AV network coordination session with the Owner and Design Professional to confirm overall project AV network requirements and set a schedule for completion and return of the Network Coordination Submittal by the Owner.

L. Owner Training Plan

- 1. Identify specific systems to be trained on and training durations.
- 2. Identify required project stakeholders.
- 3. Identify training status and provide training sign-off sheets.
- 4. Provide training materials and user one-page operations sheets for each system types.

M. Operations and Maintenance Manuals:

- 1. This Section requires complete documentation of the AV System for the purpose of system operation and maintenance during and after the Warranty period. It is intended that the operation and maintenance manuals be exhaustive in the coverage of the system to the extent that they may be used as the sole guide to the troubleshooting, identification, and repair of defective parts. All documentation, as described here-in shall be submitted to the Owner for approval sixty (60) days prior to final submission.
- 2. Scope: These manuals shall include basic wiring diagrams, schematics, and functional details such that any component, wire, or piece of equipment in the system may be easily identified by going to the actual equipment and making reference to this manual. It is required that everything in the system be neatly labeled and easily identifiable. Every

terminal, wire, component, or piece of equipment, and other such items shall have a number or letter designation. All of these identification characteristics shall be included in the maintenance and operation manuals.

3. The maintenance manual requirement of this Section is in addition to Shop Drawing requirements. Maintenance manuals and Drawing sets shall be compiled after system fabrication and testing and shall incorporate any changes made after Shop Drawing submittal. The maintenance manuals and drawing books shall be permanently bound in hard plastic covers.
4. Maintenance Manuals, Manufacturer's Literature: Provide manufacturer's standard literature, covering all equipment included in the system. The maintenance manuals shall contain specifications, adjustment procedures, circuit schematics, component location diagrams, and replacement parts identification. All references to equipment not supplied on this Project shall be crossed out.
5. System Administrator Documentation: This documentation shall provide complete information on the configuration, business rules, operation, maintenance, and troubleshooting of the system.

N. Testing Plan

1. Submit a systems testing and verification plan for approval by Owner and Design Professional.
2. The approved Testing Plan shall be completed and provided to the Owner and Design Professional prior to commencement of Owner testing and punch list efforts.

O. As-Built Documentation

1. Submit an updated version of all submittals revised to match installed conditions.
2. Submit the native version of all drawing, control programming, digital signal processing and other systems configuration files.

P. Warranty

1. Within 30 business days of award, provide a summary of the systems warrantee including all optional services for final Owner confirmation.
2. At time of as-built documentation submission provide two physical copies of the hardware and software warranty certifying that the final as-built installation is fully warranted by the manufacturer.

1.16 GENERAL WARRANTY

A. The system warranty shall commence on the date of Substantial Completion unless otherwise provided for in the Contract.

B. The system warranty shall be for an initial period of one year

C. Hardware Warranty:

1. Contractor shall warrant that all components meet or exceed the specifications provided in the product data submittal.
2. The Contractor shall warrant that the proposed merchandise will conform to its description and any applicable specifications and shall be of good quality for the known purpose for which it is intended.
3. The warranty shall cover material and labor for the replacement or repair of defective products.

4. Regardless of manufacturer warranties expiring before the full system warranty period, Contractor shall be responsible for extending any manufacturer warranties for the full length of the system warranty.

D. Software Warranty:

1. The warranty shall allow for replacement or repair at the discretion of the Owner. All software necessary to compile, modify, and maintain software developed for this specification shall be included in this warranty.
2. The warranties shall include the price of all software upgrades during the warranty period. If a new version of the system software becomes available during the warranty period, it shall be upgraded as part of the warranty.

1.17 MAINTENANCE AND SUPPORT SERVICES

- A. Description of Work: During the warranty period provide 24-hour, 7 days a week live monitoring of the system from the Contractor's operations center. Provide customer service for subscriber issues Monday – Friday, 9am – 5pm local time. Provide quarterly system inspections, checks and updates during the warranty and maintenance period.
- B. Personnel: Service personnel shall be certified in the maintenance and repair of similar types of equipment and qualified to accomplish work promptly and satisfactorily. Service personnel shall hold a valid Airport security credential. The Owner or Owner's Designated Representative shall be advised in writing of the name of the designated service representative, and of any change in personnel.
- C. Schedule of Work: The Contractor shall perform quarterly inspections of the installed system. Inspections shall be in accordance with manufacturer and Contractor recommendations. The adjustment and repair of the system shall include visual checks of installed equipment and inspection of system health logs and software. Recommended software updates shall be applied on the system at these pre-defined quarterly periods.
- D. Scheduled Work: Scheduled work shall be performed during regular working hours, Monday through Friday, excluding holidays.
- E. Emergency Service: The Owner will initiate service calls when the system is not functioning properly. Qualified personnel shall be available to provide service to the complete system repair. The Owner shall be furnished with a telephone number where the service supervisor can be reached at all times. Service personnel shall be at site within 4 hours after receiving a request for service. The system shall be restored to proper operating condition within 8 hours after service personnel arrive onsite.
- F. Records and Logs: The Contractor shall keep records and logs of each task, and shall organize cumulative records for each component, and for the complete system chronologically. A continuous log shall be maintained for all devices. The log shall contain all initial settings. Complete logs shall be kept and shall be available for inspection on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the system.
- G. Work Requests: The Contractor shall separately record each service call request, as received. The form shall include the serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the material to be used, the time and date work started, and the time and date of completion. The Contractor shall deliver a record of the work performed within 5 days after work is accomplished.

H. System Modifications: The Contractor shall make any recommendations for system modification in writing to the Owner. System modifications shall not be made without prior approval of the Owner. Any modifications made to the system shall be incorporated into the operation and maintenance manuals, and other documentation affected.

I. Spare Equipment:

1. Provide spare equipment where indicated in the systems diagrams.

#### 1.18 SERVICE LEVEL AGREEMENT (SLA)

A. The Contractor shall provide with the bid a firm fixed pricing option(s) to provide continued warranty service and maintenance of the system for additional years two and three. The SLA shall mirror that of the warranty and maintenance requirements during the warranty period as outlined in the Warranty and Maintenance articles above.

#### 1.19 DELIVERY, STORAGE, AND HANDLING

A. Contractor shall coordinate secure storage onsite with the General Contractor and is responsible for the safe delivery, storage and handling of all equipment covered in this scope of work through substantial completion of the work.

#### 1.20 PROJECT CONDITIONS

A. Environmental Limitations: System components shall be equipped and rated for the environments where installed.

B. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

C. Interior, Controlled Environment: System components shall be rated for continuous operation in ambient conditions of 2 to 40 deg C dry bulb and 20 to 90 percent relative humidity, noncondensing.

D. Interior, Uncontrolled Environment: System components installed in non-air-conditioned interior environments shall be rated for continuous operation in ambient conditions of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.

E. Verify that field measurements are as shown on Drawings; no media, fiber, or copper, shall be installed in lengths surpassing Standards based length requirements.

F. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project conditions.

G. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required. Record actual routing on as-builts for all conduit larger than one inch.

#### 1.21 PROJECT COORDINATION

A. Determine required separation between cable and other work.

B. Coordinate cable routing to avoid interference with other work disciplines.

C. Coordinate grounding and bonding with Section 270527 Contractor.

- D. Coordinate use of fiber optic cabling infrastructure with Section 271310 Contractor.
- E. Coordinate network configuration requirements with Section 272000 Contractor.

## PART 2 - PRODUCTS

2.1 Refer to systems diagrams for information and functionality.

- A. The information and functionality shall be used as the basis for Contractor pricing.
- B. Contractor shall verify any existing manufacturer quotes. Match the project requirements.
  - 1. Contractor shall be responsible for addressing any discrepancies between manufacturer quotes and project requirements.

2.2 SUBSTITUTIONS

- A. Contractor requests for substitutions shall be made in writing and shall include:
  - 1. The equipment or process requested for substitution and a summary of the reason for substitution.
  - 2. The requested equipment or process to substitute with and a feature comparison with the base scope of work.
  - 3. Proposed cost and schedule impacts.
- B. No substitution shall be allowed without written approval of the Owner or Design Professional.
- C. Cost and schedule impacts will only be considered for approval in the event that the substitution is due to factors outside of the control of the Contractor.

## PART 3 - EXECUTION

3.1 GENERAL

- A. Contractor shall install all system components including furnished equipment, and appurtenances in accordance with the manufacturer's instructions, and shall furnish all cables, connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.
- B. Grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.
- C. Contractor shall adhere to the following during installation of the system:
  - 1. Underwriters Laboratories (UL) listing for restricted access installations in business and customer premises applications. This listing is required by the National Electric Code for customer premise installations.
  - 2. Fire resistance requirements specified by Underwriters Laboratories in UL 1459, 2nd edition.
- D. Where undefined by codes and standards, Contractor shall apply a safe working load of at least five (5) times the rated load to all fastenings and supports of system components.
- E. The Contractor shall adhere to the installation schedule of the General Contractor and should attend all construction meetings scheduled by the General Contractor.

- F. Contractor shall place materials only in those locations that have been previously approved. Any other locations shall be approved, in writing, by the Owner.
- G. All wiring and cables shall be properly dressed and/or bundled with Velcro straps. Twisted wire, tape, rope, twine, phone wire and similar bits of debris usually available on site are not acceptable substitutes for proper securing hardware. All inter-rack cables and wiring must be properly routed, and where available, run in cable trays. Overhead cables must be easily removed or reworked within the cable trays. Proper care must be taken to ensure that new cables added to the trays are not stressed or intertwined with existing cables. Overhead cables may not cross perpendiculars or be suspended in mid-air without supports. No supports may be installed without prior approval from the Owner. All long cable runs must be properly identified at each end and every 100 feet indicating the carried frequency and communication room of origin. All cabling within the building must be cut to proper length.
- H. The Contractor shall obtain written permission from the Owner before proceeding with any work which requires cutting into or through any part of the building structures such as, but not limited to, girders, beams, concrete, carpeted or tiled floors, partitions or ceilings. The Contractor shall also consult with the General Contractor before cutting into or through any part of the building structures where fireproofing or moisture proofing could be impaired.

### 3.2 INSTALLATION

- A. System equipment shall not be installed until the environment is free of dust. A dust-free environment shall be considered one in which all construction work has been completed and the air handling system for the area has been operated continuously for at least two weeks with a filter change after one week. During and following installation of the system equipment, relay assemblies and equipment cabinets, the air handling system shall be kept operational continuously and shall be adjusted to maintain a positive pressure relative to building spaces outside the areas of installation. Openings into the installation spaces shall be kept closed, filters shall be changed at frequent intervals, equipment enclosures shall be kept closed, covers shall be installed and any other provisions for keeping the equipment, assemblies, and cabinets clean and free of dust and deliver shall be employed.
- B. Verify exact location and sizes of all conduit runs and back boxes prior to rough-in.
- C. All switches, connectors, outlets, etc. shall be clearly, logically, and permanently labeled during installation.
- D. All items of equipment related to the AV system shall be installed in the designated positions as defined on the drawings.
- E. All wiring terminations shall be trimmed to the required length for proper system operation and neatly dressed. No excess wire loops shall remain in the final system unless required for maintenance access. Each system wire and cable shall be clearly marked at each end.
- F. All audio and video interconnections shall use the highest quality signal path available.

### 3.3 WIRING

- A. Wiring within equipment enclosures shall be neatly grouped or tied or run in plastic snapcover wireway sections. All connections to panel mounted devices shall employ compression attached full 360° ring type or 'push-on' type terminators securely fastened to the device terminals. Wiring shall run behind the panel in a manner that is not visible from the operator's position. A 3" termination loop shall be formed immediately adjacent to each terminal.

- B. Terminal strips shall be fully insulated but allow insertion of test equipment probes. Each terminal segment shall be numbered to correspond with the drawings and conductor identification numbers.
- C. All wire and cable shall extend to each outlet location with complete electrical continuity and without any shorts or grounds. Cables shall run uninterrupted and un-spliced to each remote device.
- D. Cables shall be routed so as to maintain a separation of at least 2 feet from all heat sources and from ballasts, transformers, dimmers and all other sources of electromagnetic interference.
- E. Care shall be exercised during installation not to damage the cable insulation. Damaged cables shall be removed and replaced.
- F. Each cable termination shall be tagged and labeled.
- G. Wire color coding for all AV cabling shall be at the option of the Contractor, but each individual conductor shall be the same color throughout its entire length.
- H. After testing is complete, audio levels on all systems shall be set to levels satisfactory to the Owner.

#### 3.4 SYSTEM CONFIGURATION

- A. Contractor shall provide for configuration of all devices and software into a complete and fully operational AV System.
  - 1. All configuration files shall be provided to the Owner as part of the close-out package
    - a. Contractor shall maintain ownership of any custom software files.
    - b. Contractor shall extend to the Owner a perpetual license for use and modification of any custom software files when used with systems provided as part of this scope of work.
- B. During the installation phase of the project, the Contractor shall work with the Owner to establish the baseline configuration requirements for the different AV elements.

#### 3.5 CONFIGURATION REQUIREMENTS

- A. An IP Addressing Plan shall be coordinated, developed, and finalized with the Owner and submitted for approval prior to implementation.
- B. VLAN(s) shall be configured to support the LAN and as identified during Owner network coordination efforts.
- C. Configure AV devices for centralized management via an Owner provided workstation connected to the network. Configuration and management software for the various network components shall be installed on the workstation. Training shall include management of the AV devices via the management workstation.

#### 3.6 TESTING

- A. Project Testing: The overall Audio Visual Systems shall not be considered complete until On-Site Testing is completed. The purpose is to test the complete system and demonstrate that all

specified features and performance criteria are met. All requirements of the specification shall be tested.

- B. Contractor shall follow the *Avixa/ANSI 10:2013 Audiovisual Systems Performance Verification* testing and documentation process and submit a completed testing plan prior to final Owner and Design Professional testing.
  - 1. Design Professional may elect to request retesting of individual rooms following the *Avixa/ANSI 10:2013* standard until satisfied that systems are properly installed and configured.
- C. For any system or equipment types not covered in the *Avixa/ANSI 10:2013* standard, Contractor shall provide the proposed test plan/procedures for each testing phase for review by the Owner or Design Professional. The test plan for each phase of testing shall detail the objectives of all tests. The tests shall clearly demonstrate that the system and its components fully comply with the requirements specified herein. The submission of Test Plans shall adhere to the following:
  - 1. A draft test plan shall be presented to the Owner at least forty-five (45) days prior to the scheduled start of each test.
  - 2. A workshop for reviewing comments shall be conducted with the Owner at least thirty (30) days prior to the scheduled start of each test.
  - 3. A final test plan shall be submitted to the Owner at least fourteen (14) days prior to the scheduled start of each test.
  - 4. Test plans shall contain at a minimum:
    - a. Functional procedures including use of any test or sample data.
    - b. Test equipment is to be identified by manufacturer and model.
    - c. Interconnection of test equipment and steps of operation shall be defined.
    - d. Expected results required to comply with specifications.
    - e. Testing matrix referencing Specification requirements with specific test procedures.
    - f. Record of test results with witness initials or signature and date performed.
    - g. Pass or fail evaluation with comments.
- D. The test procedures shall provide conformity to all Specification requirements. Satisfactory completion of the test procedure is necessary as a condition of system acceptance.
- E. All Test plans must be reviewed by the Owner. To successfully complete a test, the test document must be signed and dated by both the Contractor and the Owner.
- F. The Owner will review, witness and validate the execution of all formal test procedures prepared by the Contractor and deliverable under the contract to assure the tests cover all requirements and that there is a conformity between the conducted test, the test results and Specification requirements.
- G. Documentation verification both interconnects and operationally, shall be part of the test. Where documentation is not in accordance with the installed system interconnect and operating procedures, the system shall not be considered accepted until the system and documentation correlate.
- H. The Contractor shall provide the Owner or Owner representative the opportunity to participate in any or all of tests.



- I. Test Reports: The Contractor shall prepare, for each test, a test report document that shall certify successful completion of that test. Submit to the Owner's representative for review and acceptance within seven (7) days following each test. The test report shall contain, at a minimum:
  1. System power measurement results and settings
  2. Commentary on test results
  3. A listing and discussion of all discrepancies between expected and actual results and of all failures encountered during the test and their resolution.
  4. Complete copy of test procedures and test data sheets with annotations showing dates, times, initials, and any other annotations entered during execution of the test.
  5. Signatures of persons who performed and witnessed the test
  6. Test Resolution: Any discrepancies or problems discovered during these tests shall be corrected by the Contractor at no cost to the Owner. The problems identified shall be corrected and the percentage of the entire system re-tested determined by the Owner before any subsequent testing is performed.

### 3.7 CLEANING

- A. Remove all unnecessary tools and equipment, unused materials, packing materials, and debris from each area where work has been completed unless designated for storage.

### 3.8 TRAINING

- A. The Contractor shall provide the Owner specified trainees with detailed as-built information. The training shall provide trainees with a working knowledge of the system design and layout, ability to configure and monitor the system, and troubleshooting methods and techniques. In addition, the training shall cover testing, maintenance, and repair procedures for all equipment and applications, which are provided under this Specification.
- B. Course materials shall be delivered to the Owner. Final delivery of the course materials shall include a master hard copy of all materials and an electronic copy in a format reviewed in advance by the Owner. The Contractor shall supply a video recording of each training course.
- C. All training shall be completed a minimum of two weeks prior to the system becoming operational and utilized by the Owner. Training schedule subject to the Owner's review.

### 3.9 ACCEPTANCE

- A. Acceptance will be withheld until the following have been completed successfully:
  1. Acceptance of all submittals
  2. Delivery of final documentation
  3. Successful testing
  4. Completion of training
  5. Demonstrate system to designated Owner personnel as required by applicable sections of these specifications. Use submitted operation and maintenance manual as reference during demonstration and training. Demonstrate as-built records are in format required and can lead troubleshooting technicians to port level of detail in field.

END OF SECTION

SECTION 275223

NURSE CALL/CODE BLUE SYSTEMS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.
  
- B. Related Sections:
  - 1. Division 07 – Through-penetration Firestop Systems
  - 2. Division 26 – Common Work Results for Electrical
  - 3. Division 26 – Low Voltage Electrical Power Conductors and Cables
  - 4. Division 26 – Grounding and Bonding for Electrical Systems
  - 5. Division 26 – Hangers and Supports for Electrical Systems
  - 6. Division 26 – Raceways and Boxes for Electrical Systems
  - 7. Division 26 – Identification for Electrical Systems
  - 8. Division 27 – General Requirements for Telecommunications
  - 9. Division 27 – Common Work Elements for Communications Systems
  - 10. Division 27 – Network Communications Systems
  - 11. Division 27 – Two-Way Communications System
  - 12. Division 27 – Audiovisual Systems
  - 13. Division 27 – Nurse Call/Code Blue
  - 14. Division 28 – Common Work Elements for Electronic Safety and Security
  - 15. Division 28 – Physical Electronic Safety and Security
  - 16. Division 28 – Video Surveillance System
  
- C. Section includes visual/tone nurse-call system.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
  
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Equipment cabinets.
  - 2. Cabling diagrams.
  - 3. Station installation details.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
  
- B. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Compatibility: System shall be capable of integration with any brand of phone system (wired or wireless), staff locating system, CCTV, and fire-alarm system.
- C. Electrical Components, Devices, and Accessories: Listed and labeled according to UL 1069 as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 1.6 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for 2 years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within 2 years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
- C. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

## PART 2 - PRODUCTS

### 2.1 NURSE-CALL SYSTEM GENERAL REQUIREMENTS

- A. Manufacturer: Jeron 790 Systems. No substitutions.
- B. Station Zones: Able to program 256 station zones for each master station in the network with a minimum of 8 priority levels and addressable visual and audible annunciation of audible devices such as smoke detectors and door contacts.
- C. System shall provide integrated and centralized "Code Blue" and "Staff Emergency" calls.
- D. Expansion Capability: Equipment ratings, housing volume, spare keys, switches, relays, annunciator modules, terminals, and cable conductor quantities adequate to increase the number of stations in the future by 25 percent above those indicated without adding internal or external components or main trunk cable conductors.
- E. Resistance to Electrostatic Discharge: System, components, and cabling, and the selection, arrangement, and connection of materials and circuits, shall be protected against damage or diminished performance when subjected to electrostatic discharges of up to 25,000 V in an environment with a relative humidity of 20 percent or less.
- F. Equipment: Microprocessor, electronic, modular.
- G. Master Nurse-Call Station: Programmed via a PC.
- H. Wall-Mounted Component Connection Method: Components connect to system wiring in back boxes with factory-wired plug connectors.
- I. Telephone Interface: Permit use of wired and wireless telephones to execute nurse-call master station functions.

- J. Third-Party Pager Interface: Programmable to send tone, numeric, and alphanumeric message to pocket pagers or personal digital assistants and to use industry standard-protocol, RS-485 interface.

## 2.2 VISUAL/TONE NURSE-CALL SYSTEM

### A. Operational Requirements:

1. Patient Station Call: Lights a steady call-placed lamp on the station, steady lamps in the zone light and corridor dome light associated with the patient's room, and steady lamps at the central annunciator and other system display devices and displays message on master and staff/duty stations. At the same time, it sounds a programmed tone at intervals, at the respective annunciator and master and staff/duty stations. Legends at the central annunciator and master station identify the calling station.
2. Pull-Cord-Call Station Call: Flashes a call-placed lamp on the station and distinctive-color lamps in the zone light and corridor dome light and at the central annunciator and staff/duty stations. At the same time, it sounds a programmed tone at intervals, at the central annunciator and master and staff/duty stations. A legend at the master station identifies the calling station, priority as programmed, and bed identification.
3. Emergency-Call Station Call: Produces the same responses as pull-cord-call station calls except rapidly flashing red emergency digital display and tone repetition rates are more frequent, tone frequency is higher, and lamps in the zone light and corridor dome light are a different color. Indicator lamps may be turned off and the system reset only at the calling station. Displays message on pocket pagers, sounds programmed tone on phones, and displays message on display equipped phones.
4. System Reset: Operating reset button at the originating station cancels signals associated with the call. Illuminates a green digital display on the patient station and log presence on the master station.
5. Cord-Set Removal: Initiates a patient station call when the cord set is removed from the jack in the patient station faceplate. Displays location and "cord removed" message on master station, pocket pagers, and display equipped phones. Inserting a cord-set plug or a dummy plug into the jack and operating the station reset button resets the call.
6. Patient Control Unit: Controls entertainment volume and channel selection. Nurse button on the unit initiates a patient station call. Integral speaker reproduces entertainment sound.
7. Emergency Bath Station Call: Illuminates the digital display on the emergency bath station; rapidly flashes white dome lamp; displays location, priority, and bath on master station; and sounds programmed tone on master station display equipped phones and pocket pagers.
8. Staff/Duty Station Operation: Operation shall be identified to patient station except the message staff shall display on all devices when the staff call button is activated.
9. Privacy Key Activation: When privacy key is activated on patient station, the system shall disconnect the patient station microphone and slowly flash yellow privacy digital display on the patient station. Displays "privacy" on master station when selecting this room/bed.

### B. Central Annunciator:

1. Lamp type.
2. Lamp Legends: Machine lettered and legible from a distance of at least 48 inches when a call is present. Legend shall identify initiating station and priority of call.
3. Power-on Indicator: Digital, or push-to-test switch.
4. Audible Signal: Electronic tone.

### C. Central Equipment Cabinet:

1. Lockable metal.

2. Houses power supplies, controls, terminal strips, and other components.
3. Power-on indicator lamp.

D. Single-Patient Station: Call-placed lamp, reset push button, and polarized receptacle matching cord-set plug; mounted in a single faceplate.

E. Staff/Duty Stations: A minimum of two call lamps, one for routine calls and one for emergency calls; and an audible tone signal device.

## 2.3 SYSTEM COMPONENTS

A. Emergency-Call Station: Locking-type push button, labeled "Push to Call Help"; reset trigger to release push button and cancel call; and call-placed lamp, mounted in a single faceplate.

B. Emergency-Bath Station:

1. Consists of a sliding, chemical-resistant, ABS red fascia marked with the word "URGENT" in bold letters.
2. Capable of being activated with nylon pull cord or by sliding the face of the unit downwards.
3. Activation of the station shall illuminate a reassurance digital display on the face of the unit in addition to notifying the master station.
4. Water resistant and able to withstand routine cleaning and chemical disinfectants.
5. Uses magnetic reed switch technology for reliability and corrosion resistance.
6. Mounts on a single-gang electrical box wire to the respective patient station or input controller.

C. Staff, Emergency Station:

1. Consists of a sliding, chemical-resistant, ABS red fascia marked with the word "EMERGENCY" in bold letters.
2. Capable of being activated with nylon pull cord or by sliding the face of the unit downwards.
3. Activation of the station shall illuminate a reassurance digital display on the face of the unit in addition to notifying the master station.
4. Mounts on a single-gang electrical box wire to the input controller.

D. Pull-Cord-Call Station:

1. Pull-Down Switch: Lever-locking type, labeled "Pull Down to Call Help."
2. Reset trigger.
3. Call-placed lamp.
4. Water-resistant construction.

E. Patient Control Unit:

1. Equipped with plug and 96-inch long white cord.
2. Ethylene oxide, sterilizable.

F. Pillow Speakers:

1. Eight-conductor, DIN, flexible PVC jacketed cable.
2. Contain nurse-call button, volume control, speaker, and channel control in molded flame-retardant ABS housing.
3. Cord: 96 inches long with sheet clip.

G. Call-Button Plug:

1. Designed to plug into patient station cord-set receptacle.
2. Button switches call circuit.
3. Two plugs for every 10 patient beds.

H. Dummy Plugs:

1. Designed to plug into patient station cord-set receptacle when call-button plug or patient cord set is not used.
2. Three plugs for every 10 patient beds.

I. Indicator Lamps: Digital type with rated life of 20 years unless otherwise indicated.

J. Station Faceplates:

1. Stainless steel, a minimum of 0.0375 inch thick.
2. Finish: Brushed.
3. Machine-engraved labeling identifies indicator lamps and controls.

K. Corridor Dome Lights and Zone Lights:

1. Three-lamp signal lights.
2. Lamps: Front replaceable without tools, low voltage with rated life of 7500 hours. Barriers are such that only one color is displayed at a time.
3. Lenses: Heat-resistant, shatterproof, translucent polymer that will not deform, discolor, or craze when exposed to hospital cleaning agents.

L. Cable:

1. Conductors: Jacketed single and multiple, twisted-pair copper cables.
2. Sizes and Types: As recommended by equipment manufacturer.
3. Cable UL-Listed and labeled for plenum installation.

M. Grounding Components: Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."

## 2.4 SOFTWARE REQUIREMENTS

A. Telephone System Interface:

1. Permits use of wired and/or wireless telephones to execute nurse-call master station.
2. Two-way communication with patient and staff stations.
3. Two-way communication with the master nurse station.
4. "All Call," group call, and staff call paging.
5. Capable of being programmed to forward calls destined for a master nurse station to any connected telephone.
6. Telephones connected to the telephone interface shall have the same call tone ring patterns as those generated at the master nurse station.
7. Telephones having a display shall indicate the call type, priority code, and the calling station number of incoming calls.
8. Telephones shall be capable of initiating a service request for a particular patient station, logging calls on the master station's reminder list, and activating door lock mechanisms associated with a call station.

9. Capable of routine setup and configuration changes using the keypads on display telephone and/or the master station.

B. Display Telephones:

1. Digital telephones for use as mini-master nurse-call stations.
2. Digital display shall indicate the call type, priority code, and calling station number of incoming calls.
3. Ring patterns shall be identical to those generated at the master station.
4. Capable of two-way communication with patient and staff stations and the master station, and other telephones interfaced with the system.
5. Capable of placing or answering outside calls when interfaced with the facility telephone system.
6. Capable of "All Call," group call, and staff call paging and of initiating service requests, logging calls to the reminder list, and activating optional door controls.

C. Third-Party Pocket Pager Interface:

1. Equipped with a standalone pocket pager interface.
2. Connects with the facility paging system and transmit alphanumeric messages to the pocket pagers as preprogrammed in the system.

D. Statistical Software:

1. Includes a data statistical software package that stores, sorts, and analyzes activities occurring on the nurse-call system network.
2. Windows based and operated on a PC that is connected to the nurse-call system network.
3. Stores events on the PC's hard disk. Accumulation of these stored events shall make up the database that is used to generate reports and statistics.
4. Events stored by the software shall include date, day of week, time, ward, priority, and room number.
5. Capable of assigning a patient name to bed number.
6. Stored events shall include, but not be limited to, calls placed, call priority, calls cancelled at the nurse station, calls cancelled at the point of origin, regenerated calls, calls answered, calls sent to pager interface, staff presence registration, staff presence cancellation, service request, service cancellation, and system and network error messages.

E. Data Analysis Software:

1. Capable of analyzing the stored information and generating computed analysis.
2. Analysis of the database can be conducted by specifying one, many, or all of the following parameters of the database: date, day of week, time, wards, priority, and room number.
3. Analysis shall include, but not be limited to, total number of calls placed, average call response time (from call placed to call cancellation), total number of presence registrations, average presence time in a room, total number of service requests, average response time (from audio answer to call cancellation), and average ring time (from call placed to audio answer).

F. Statistical Software Package:

1. Capable of displaying multiple calls/events on a PC monitor or on a RS-485 data-bus-driven digital display panel.

2. Calls from patient or staff stations and associated devices shall be displayed by priority. Display shall be customizable as follows:
  - a. Choice of color by type of call.
  - b. Choice of display size (character size).
  - c. Choice of priority levels, type of events, points of origin.
  - d. Identification of facility.
  - e. Identification of ward.
  - f. Identification of patient with specific patient information.

## 2.5 CONDUCTORS AND CABLES

### A. Audio Cables:

1. Conductors: Jacketed, twisted-pair and twisted-multipair, untinned solid copper. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG.
2. Insulation: Thermoplastic, not less than 1/32 inch thick.
3. Minimum Shielding Coverage on Conductors: 60 percent.
4. Plenum Cable: Listed and labeled for plenum installation.

### B. Data Cable and Hardware: Category 6 balanced twisted-pair cabling and hardware. Comply with requirements in Section 271500.

### C. Power Conductors and Cables: Copper, solid, No. 20 AWG. Comply with requirements in Section 26519 "Low-Voltage Electrical Power Conductors and Cables."

### D. Grounding Conductors and Cables: Copper, stranded, No. 16 AWG. Comply with requirements in Section 260516 "Low-Voltage Electrical Power Conductors and Cables."

## PART 3 - EXECUTION

### 3.1 INSTALLATION

#### A. Wiring Method:

1. Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used.
  - a. Install plenum cable in environmental air spaces, including plenum ceilings.
  - b. Conceal raceway and cables except in unfinished spaces.
2. Conduit and Boxes: Comply with requirements in Section 270528 "Pathways for Communications Systems."

#### B. Install cables without damaging conductors, shield, or jacket.

#### C. Do not bend cables, while handling or installing, to radii smaller than as recommended by manufacturer.

#### D. Pull cables without exceeding cable manufacturer's recommended pulling tensions.

1. Pull cables simultaneously if more than one is being installed in same raceway.
2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.



3. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips, that will not damage media or raceway.
- E. Install exposed raceways and cables parallel and perpendicular to surfaces or exposed structural members and follow surface contours. Secure and support cables by straps, staples, or similar fittings designed and installed so as not to damage cables. Secure cable at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, or fittings.
  - F. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
  - G. Separation of Wires: Separate speaker/microphone, line-level, speaker-level, and power-wiring runs. Run in separate raceways or, if exposed or in same enclosure, provide 12-inch minimum separation between conductors to speaker/microphones and adjacent parallel power and telephone wiring. Provide separation as recommended by equipment manufacturer for other conductors.
  - H. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Install terminal cabinets where there are splices, taps, or terminations for eight or more conductors.
  - I. Impedance and Level Matching: Carefully match input and output impedances and signal levels at signal interfaces. Provide matching networks if required.
  - J. Identification of Conductors and Cables: Comply with requirements in Section 270553 "Identification for Communications Systems" for cable administration, cable schedule, and cable and wire identification.
  - K. Equipment Identification:
    1. Comply with requirements in Section 270553 "Identification for Communications Systems" for equipment labels and signs and labeling installation requirements.
    2. Label stations, controls, and indications using approved consistent nomenclature.

### 3.2 GROUNDING

- A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other signal impairments.
- B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding except at connection to main building ground bus.
- C. Grounding Provisions: Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."

### 3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Schedule tests a minimum of seven days in advance.
2. Report: Submit a written record of test results.
3. Operational Test: Perform an operational system test and demonstrate proper operations, adjustment, and sensitivity of each station. Perform tests that include originating station-to-station and "All Call" messages and pages at each nurse-call station. Verify proper routing, volume levels, and freedom from noise and distortion. Test each available message path from each station on the system. Meet the following criteria:
  - a. Speaker Output: 90 dB plus or minus 3 dB, 300 to 3000 Hz, reference level threshold of audibility 0 dB at 0.02 mPa of sound pressure.
  - b. Gain from patient's bedside station to nurse station, with distortion less than 65 dB (plus or minus 3 dB, 300 to 3000 Hz).
  - c. Signal-to-Noise Ratio: Hum and noise level at least 45 dB below full output.
4. Test Procedure:
  - a. Frequency Response: Determine frequency response of two transmission paths by transmitting and recording audio tones.
  - b. Signal-to-Noise Ratio: Measure the ratio of signal to noise of the complete system at normal gain settings using the following procedure: Disconnect a speaker/microphone and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure the ratio of signal to noise and repeat the test for four speaker microphones.
  - c. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 300, 400, 1000, and 3000 Hz into each nurse-call equipment amplifier and measure the distortion in the amplifier output.

D. Retesting: Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify, by the system test, that the total system meets these Specifications and complies with applicable standards. Report results in writing.

E. Inspection: Verify that units and controls are properly labeled, and interconnecting wires and terminals are identified.

F. Prepare test and inspection reports.

### 3.4 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sound levels and controls to suit actual occupied conditions. Provide up to 3 visits to Project during other-than-normal operating hours for this purpose.

### 3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel and caregiver staff to adjust, operate, and maintain nurse-call equipment.

END OF SECTION

## SECTION 280500

### COMMON WORK ELEMENTS FOR ELECTRONIC SAFETY AND SECURITY

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.
- B. Related Specification Sections:
1. Division 07 – Through-penetration Firestop Systems
  2. Division 26 – Common Work Results for Electrical
  3. Division 26 – Low Voltage Electrical Power Conductors and Cables
  4. Division 26 – Grounding and Bonding for Electrical Systems
  5. Division 26 – Hangers and Supports for Electrical Systems
  6. Division 26 – Raceways and Boxes for Electrical Systems
  7. Division 26 – Identification for Electrical Systems
  8. Division 27 – General Requirements for Telecommunications
  9. Division 27 – Common Work Elements for Communications Systems
  10. Division 27 – Network Communications Systems
  11. Division 27 – Two-Way Communications System
  12. Division 27 – Audiovisual Systems
  13. Division 27 – Nurse Call/Code Blue
  14. Division 28 – Common Work Elements for Electronic Safety and Security
  15. Division 28 – Physical Electronic Safety and Security
  16. Division 28 – Video Surveillance System
- C. Reference Symbols:
1. All device symbols are defined by the appropriate symbol schedule on the symbols and abbreviations sheet in the communications system drawing package. Not all device symbols as indicated may be required for the project.
    - a. Because of the scale of the drawings, symbols are shown on the drawings as close as possible to the mounting location. Contractor shall coordinate exact locations with architectural drawings and all affected trades prior to submittal of shop drawings.
- D. Abbreviations:
1. ASIS: American Society Industrial Security (International)
  2. AP: Wireless Access Point
  3. A/V: Audio Visual Systems – For purposes of this specification section A/V systems shall include all Media Management, Video Broadcasting, Intercommunications (Paging/Public Address, Clock, Auxiliary Sound), Video Intercom, Emergency Communications, Mass Notification, Master Antenna (MATV) and Distance Learning Systems.
  4. AVI Audio Visual Systems Integrator: Shall be a qualified contractor experienced in the installation and certification of A/V systems. The AVI contractor shall be responsible for the design, testing and certification of all audio/visual systems including but not limited to Intercommunications, TV Distribution, Audio/Visual, Master Antenna and Bi-

- Directional Antenna systems as well as all structured cabling systems supporting these technologies. The AVI shall be RCDD registered certified for the installation and commissioning of all structured cabling networks and communications systems.
5. BACnet: A communications protocol for building automation and control networks as outlined in ISO 16484-5 and ASHRAE/ANSI Standard 135.
  6. BAS: Building Automation System
  7. BICSI: Building Industry Consultant Services International-International organization whose primary objective is to enhance the reputation and skills of companies and individuals employed in the telecommunications and security industries by ensuring that current and developing standards are maintained.
  8. CATV: Community Antenna Television System – Cable TV Network
  9. CCD: Charge-coupled device.
  10. CCTV: Closed Circuit Television Surveillance System.
  11. CMOS: Complementary metal–oxide–semiconductor
  12. CP: Consolidation Point - Local Interconnection Point between horizontal cables from the building IDF/MDF rooms and horizontal cables for the furniture drops.
  13. CPU: Central Processing Unit
  14. DP: Demarcation Point - The point of interface between the Communications Networks, MATV, any Auxiliary Systems, and the associated Service Providers or Public Utilities. Also known as Entrance Facility. Shall also serve as the primary termination point for all incoming OSP cabling as well as the primary main grounding bus-bar for all communications systems. Refer to project documents for exact location and termination requirements.
  15. DVR Digital Video Recorder.
  16. DTS: Digital Termination Service: A microwave-based, line-of-sight communications provided directly to the end user.
  17. DVT Remote digital viewing terminal which shall serve as the video surveillance systems' operator HMI terminal remote from the primary rack mounted HMI.
  18. EMI: Electromagnetic interference.
  19. EMT: Electric Metallic Tubing.
  20. ESS Electronic Security Systems – Including but not limited to; intrusion detection, physical access control, CCTV video surveillance, electronic perimeter detection, duress alarm, programmable logic controllers (PLC), supervisory control and data acquisition (SCADA), integrated security management platforms and electronic screening systems.
  21. ESSI: Electronic Security Systems Integrator – Shall be a qualified contractor experienced in the design, programming, installation, testing and certification of all Intrusion Alarm, Access Control, CCTV Surveillance and Security Management Systems. The ESSI shall have a registered RCDD professional review and seal the designs, installations and certifications of all structured cabling networks related to the installation of any IP based electronic security system.
  22. EVAC: UL Listed Emergency Voice Evacuation System. Not to be confused with the building; Public Address/Intercom, Intercommunications and/or Mass Notification systems.
  23. FAS: Fire Alarm System
  24. FASI: Fire Alarm System Integrator – Shall be a NICET Level III certified contractor experienced in the installation, programming, testing and certification of Rescue Assistance, Protected Premises and Central Station Signaling Fire Alarm Systems as defined by NFPA 72.
  25. GAP Graphic Annunciator Panel – A custom fabricated fixed display panel providing operational control and visual display of all alarm and system functions related to the operation of the FAS and/or ESSM as described in related specification sections.

- 26. GFI: Ground fault interrupter.
- 27. GUI: Graphic User Interface – A specialized program employing graphical display maps of a facility and/or site which, also provides a manual user interface for all system functions and operations by utilizing control and annunciation ICON's from dedicated human machine interface terminals.
- 28. HMI: Human Machine Interface – A Computer-operated, video control terminal complying with FCC Part 15 CFR Title 47, Subparts A and B, and shall utilize multiple dynamic GUI based displays for annunciation and control LCD flat panel computer monitor or display screen as defined by related specification sections.
- 29. ICS: Intercommunications system – Shall include but not limited to all intercoms, public address, clock, program, and auxiliary sound or emergency communications systems as defined by related specification sections.
- 30. IDF: Intermediate Distribution Frame – The room/space that shall serve as the local termination point for all horizontal and backbone cabling. Also shall be known as Equipment Room (ER), Horizontal Cross-Connect (HC) or Floor Distribution (FD).
- 31. IDS: Intrusion Detection System.
- 32. I/O: Input/Out – Commonly associated with dry/contact relay based digital integration.
- 33. ITS: Information Transport Systems – For purposes of this specification section ITS shall include all data and telecommunications communications systems including but not limited to all Data, Telephone, Intercommunications (Paging/Public Address), TV Distribution Systems (MATV) and Audio Visual Systems (A/V) and IP based CCTV Surveillance Systems.
- 34. ITSI: Information Technology System Integrator – Shall be a qualified contractor experienced in the installation and certification of all data, telecommunications and A/V systems. The ITSI shall be responsible for the design, testing and certification of Data, Telephone communications systems and all structured cabling systems supporting these technologies.
- 35. LAN: Local Area Network
- 36. LCD: Liquid-crystal display.
- 37. LED: Light Emitting Diode.
- 38. LV: Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- 39. MATV: Master Antenna System – Shall include all TV and media management distribution cabling, termination jacks, head-end components, control, equipment racks, amplifiers, projection equipment and video monitoring devices as defined by the project drawings and related specification sections.
- 40. MDF: The Main Distribution Frame – The room/space that shall serve as the primary termination point for all backbone cabling to each IDF locations and horizontal connection point for local communication drops. May also serve as a local IDF location as well as the cross-connection and interconnection of all entrance cables from the DP for all PSTN and WAN connections. Also shall be known as Main Cross Connect (MC), Telecommunications Room (TR) and/or Campus Distributor (CD)
- 41. M-JPEG: Motion – Joint Photographic Experts Group.
- 42. MPEG: Moving picture experts group.
- 43. NEC: National Electric Code
- 44. NEMA: National Electrical Manufacturers Association
- 45. NFPA: National Fire Protection Association
- 46. NTSC: National Television System Committee.
- 47. NRTL: Nationally Recognized Testing Laboratory.
- 48. NVR: Network Video Recorder
- 49. NVS: Network Video Server

- 50. OTDR: Optical Time Domain Reflectometer
- 51. OSP: Outside Plant – All cabling associated with building services supporting the incoming service connections to Service Providers, Public Utilities and Wide Area Networks.
- 52. PA: Public Address or Building Intercommunications System.
- 53. PACS: Physical Access Control System.
- 54. PIDS: Perimeter Intrusion Detection System
- 55. PIR: Passive Infrared
- 56. POTS: Plain Old Telephone Service – Analog Telephone Circuit used for the connection of FAX machines, BAS and FAS communications devices and shall be wired upstream of the facility's telephone switch.
- 57. PSP: Physical Security Professional as registered by the American Society of Industrial Security-International (ASIS)
- 58. PSTN: Public Switched Telephone Network – Connection to local telephone utility providing local telephony communications service.
- 59. RCDD: BICSI accredited Registered Communications Distribution Designer
- 60. RFI: Radio-frequency interference.
- 61. RIGID: Rigid conduit is galvanized steel tubing, with a tubing wall that is thick enough to allow it to be threaded.
- 62. RS-232: A TIA/EIA standard for asynchronous serial data communications protocol between terminal devices. This standard defines a 25-pin connector and certain signal characteristics for interfacing computer equipment.
- 63. RS-485: A TIA/EIA standard for multipoint communications protocol.
- 64. SCADA: Supervisory Control and Data Acquisition – A system used in to monitor and control plant status of facilities scattered over wide geographic areas.
- 65. SMS: Security Management System – A system incorporating security alarms, door controls, emergency intercoms/paging, duress alarms and surveillance systems all integrated through a single operating platform, providing centralized command and control capability for the various systems via dedicated human machine interface terminals.
- 66. TCP/IP: The standard communications protocol that implement protocol stack on which the Internet and data communications networks operate
- 67. TGB: Telecommunications Grounding Busbar – Located in each IDF
- 68. TMGB: Main Grounding Busbar – Located at the building DP/MDF
- 69. TP: Transition Point – A location in the horizontal cabling where flat under-carpet cable transitions to a horizontal cabling consolidation point (CP).
- 70. TVSS: Transient voltage surge suppressor
- 71. VLAN: Virtual LAN – A technique made possible by switching technologies that permits the logical grouping of any number of network devices into one or more sub- networks.
- 72. UPS: Uninterruptible Power Supply
- 73. UTP: Unshielded Twisted Pair
- 74. VMS: Video Management Software which shall software that incorporates multiple security subsystems (e.g., physical access control, intrusion detection, closed circuit television, intercom) into a single platform and graphical user interface.
- 75. VoIP: Voice Over IP telephone Network
- 76. WAN: Wide Area Network
- 77. WLAN: Wireless Local Area Network

E. Definitions:

1. Contract Documents: The documents consisting of the Form of Agreement between Owner and Contractor, Conditions of the Contract, (General, Supplementary, and other Conditions), Drawings, Specifications and all Addenda issued prior to the execution of the Contract.
2. Contract Drawings: The drawings that form a part of the Contract Documents that provides the graphical representation of the project requirements intended design and/or performance criteria to be delivered by the Contractor.
3. Reference Drawings: A drawing and/or set of drawings produced by a proprietary supplier, manufacturer, subcontractor, or fabricator included in the Contract Documents for informational purposes, providing specific information related to the installation of related appurtenances, components, devices, hardware, products and/or systems. Reference Drawings shall also include any Contract Drawings from prior bid packages that may have pertinent information or require coordination of trades related to this contract.
4. Shop Drawings: A drawing and/or set of drawings produced by the contractor, supplier, manufacturer, subcontractor, or fabricator as a detailed representation of the proper installation of the related, appurtenance, component, device, hardware, product and/or system to be delivered in conformance to the requirements of the Contract Documents.

## 1.2 SUMMARY

- A. This Section contains the overall requirements associated with all Division 28 Specification Sections and includes the project design intent for all electronic security systems (ESS) as well as requirements for submittals, quality assurance, product handling, record documents, project conditions, installation, system performance, demonstrations, testing, training and certifications for all scopes of work related to these systems. Refer to related specification sections and contract drawings for additional information.
  1. The Division 26 contractor shall act as the prime contractor for the project and who herein shall be known as the "Contractor".
- B. The ESS1 shall be a sub-contractor to the Division 26 contractor and shall have overall responsibility for all designs, equipment and all technical support related to all Division 28 scopes of work and shall ensure full coordination of all work with relationship to the Division 26 contractor as required to provide fully operational security systems as herein specified and in accordance with all requirements of the related specification sections and contract drawings.
- C. It shall be the responsibility of the Contractor to furnish and install all necessary cabling, conduits/raceways, cable terminations, controls, systems, equipment, materials, devices, components, electrical power, equipment racks/cabinets and software as well as all appurtenances, programming, commissioning and testing necessary to deliver complete and fully operational systems as indicated by all division 28 specification sections and related contract drawings.
  1. The installation, performance, features, functions, software and programming criteria as specified herein as well as all related Division 28 specification sections have been designed to offer the maximum system efficiency, ease of operation, occupant safety and the protection of equipment as recommended by the Veterans Administration (VA) and Design Professional.
  2. Any deviations from the specified criteria shall be documented, reviewed and agreed to in writing by Owner and Design Professional prior to submission of bids. Refer to Division 1, and all related Division 28 specification sections for any substitutions and/or project deviation requests.

- 1) The required information shall include but not limited to: reason for deviation, all differences in performance, operation and function from the herein specified requirements, all benefits and added features to the Owner as a result of the deviations and any additional incurred costs to the Owner for maintenance and long term ownership.
  - 2) Failure to provide the Owner and Design Professional with the required information shall result in any shop drawing submissions being returned for non- conformance with the contract requirements.
3. The contractor and all sub-contractors for this work shall have read all of the General Conditions, Special Requirements, General Requirements, Division 1 and all related specification sections and in the execution of all work shall be bound by all of the conditions and requirements therein.
  4. Prior to the submission of the Bid any discrepancies or inconsistencies noted within these specifications and/or the project drawings shall be brought to the immediate attention of the Owner and Design Professional.
  5. All device symbols are defined by the appropriate symbol schedules as indicated by the symbol and abbreviation drawing sheets for each discipline. The Contractor shall coordinate exact locations with all architectural, mechanical, electrical, reflected ceiling, furniture drawings and door hardware specifications as well as all affected trades prior to submittal of bids.
  6. All symbols are shown on the contract drawings as close as possible to their intended location. Contractor shall coordinate the installation of all equipment, devices, controls, components, cabling conduits/raceways and integration of other systems with all affected trades and specified system integrators. The contractor shall document all coordination requirements at the time of shop drawing submission.
- D. Drawings for this work are diagrammatic and intended to convey the extent, general arrangement and locations of the work. Because of the scale of the drawings, certain basic items such as access panels, conduits, cabinet sizes, penetration sleeves, pull boxes, back-boxes and junction boxes may or may not be shown on the contract drawings. Include all items where required by code and related specification sections for proper installation of all work.
- E. Where ambiguity exists between the project specifications and the contract drawings, the superior in system performance regardless of cost shall prevail and shall be delivered by the Contractor at no additional expense to the project.
1. Project specifications and drawings may not deal individually with every part, control, device, component, or appurtenance which may be required to produce the equipment performance for the specified system and/or as required for compliance with all specified systems integration.
    - 1) Include such items and components, as required, for complete operational systems as defined by the project documents, whether or not specifically indicated. The contractor shall be responsible for providing conduits/raceways, cable terminations, controls, systems, equipment, materials, devices, components, electrical power, equipment racks/cabinets, software, programming, commissioning, testing and all appurtenances as well as the integration of any ancillary systems or Owner provided equipment/components/systems.
    - 2) Coordinate with other applicable trades in submittal of shop drawings and the installation of all systems. All shop drawings shall detail space conditions in order to accommodate other concerned trades, all equipment locations are subject to final review by the Owner and Design Professional.



### 1.3 REFERENCES

- A. References to industry and trade association standards as well as all building codes are minimum installation requirements. The codes, standards and agencies listed below shall form a part of this specification section and all work shall comply with the latest adopted standards.
- B. The publications listed below (including amendments, addenda, revisions, supplement, and errata) form a part of this and all related division 28 specification sections to the extent referenced. The publications are referenced in the text by the basic designation only.
- C. Where the contract drawings and specifications mandate a greater requirement or performance than those specified by any of the below referenced codes and standards, the Contract Documents shall then be the governing requirements for this project. The minimum codes and standards to be applied for this project shall be the following:
  - 1. American National Standards Institute (ANSI)/ International Code Council (ICC):
    - a. A117.1 - Standard on Accessible and Usable Buildings and Facilities
  - 2. American National Standards Institute (ANSI)/ Security Industry Association (SIA):
    - a. AC-03 - Access Control: Access Control Guideline Dye Sublimation Printing Practices for PVC Access Control Cards
    - b. CP-01-00 - Control Panel Standard-Features for False Alarm Reduction
    - c. PIR-01-00 - Passive Infrared Motion Detector Standard - Features for Enhancing False Alarm Immunity
    - d. TVAC-01 - CCTV to Access Control Standard - Message Set for System Integration
  - 3. American National Standards Institute (ANSI):
    - a. 330-09 - Electrical Performance Standards for CCTV Cameras
    - b. 375A-76 - Electrical Performance Standards for CCTV Monitors
  - 4. American National Standards Institute (ANSI):
    - a. ANSI S3.2-99 - Method for measuring the Intelligibility of Speech over Communications Systems
  - 5. American Society for Testing and Materials (ASTM)
    - a. B1-07 - Standard Specification for Hard-Drawn Copper Wire
    - b. B3-07 - Standard Specification for Soft or Annealed Copper Wire
    - c. B8-04 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
    - d. C1238-97 (R03) - Standard Guide for Installation of Walk-Through Metal Detectors
    - e. D2301-04 - Standard Specification for Vinyl Chloride Plastic Pressure Sensitive Electrical Insulating Tape
  - 6. Department of Justice: American Disability Act (ADA)
    - a. 28 CFR Part 36-2010 - ADA Standards for Accessible Design
  - 7. Federal Communications Commission (FCC):

- a. (47 CFR 15) Part 15 - Limitations on the Use of Wireless Equipment/Systems
8. Federal Information Processing Standards (FIPS):
- a. FIPS-201-1 - Personal Identity Verification (PIV) of Federal Employees and Contractors
9. Federal Specifications (Fed. Spec.):
- a. A-A-59544-08 - Cable and Wire, Electrical (Power, Fixed Installation)
10. Owner Accountability Office (GAO):
- a. GAO-03-8-02 - Security Responsibilities for Federally Owned and Leased Facilities
11. Homeland Security Presidential Directive (HSPD):
- a. HSPD-12 - Policy for a Common Identification Standard for Federal Employees and Contractors
12. Institute of Electrical and Electronics Engineers (IEEE):
- a. 81-1983 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
  - b. 802.3af-08 - Power over Ethernet Standard
  - c. 802.3at-09 - Power over Ethernet (PoE) Plus Standard
  - d. C2-07 - National Electrical Safety Code
  - e. C62.41-02 - IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
  - f. C95.1-05 - Standards for Safety Levels with Respect to Human Exposure in Radio Frequency Electromagnetic Fields
13. International Building Code (IBC)
14. International Organization for Standardization (ISO):
- a. 7810 – Identification cards – Physical characteristics
  - b. 7811 – Physical Characteristics for Magnetic Stripe Cards
  - c. 7816-1 – Identification cards - Integrated circuit(s) cards with contacts - Part 1: Physical characteristics
  - d. 7816-2 – Identification cards - Integrated circuit cards - Part 2: Cards with contacts - Dimensions and location of the contacts
  - e. 7816-3 – Identification cards - Integrated circuit cards - Part 3: Cards with contacts - Electrical interface and transmission protocols
  - f. 7816-4 – Identification cards - Integrated circuit cards - Part 11: Personal verification through biometric methods
  - g. 7816-10 – Identification cards - Integrated circuit cards - Part 4: Organization, security and commands for interchange
  - h. 14443– Identification cards - Contactless integrated circuit cards; Contactless Proximity Cards Operating at 13.56 MHz in up to 5 inches distance
  - i. 15693 – Identification cards -- Contactless integrated circuit cards - Vicinity cards; Contactless Vicinity Cards Operating at 13.56 MHz in up to 50 inches distance
  - j. 19794 – Information technology - Biometric data interchange formats
15. The Joint Commission (TJC) formally - Joint Commission on Accreditation of Healthcare Organizations (JCAHO)

16. National Electrical Contractors Association
  - a. 303-2005 – Installing Closed Circuit Television (CCTV) Systems
17. National Electrical Manufacturers Association (NEMA):
  - a. 250-08 – Enclosures for Electrical Equipment (1000 Volts Maximum)
  - b. TC-3-04 – PVC Fittings for Use with Rigid PVC Conduit and Tubing
  - c. FB1-07 – Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
18. National Fire Protection Association (NFPA):
  - a. 70-2011 – National Electrical Code (NEC)
  - b. 72-2010 – National Fire Alarm and Signaling Code
  - c. 90A 2009 – Installation of Air Conditioning and Ventilating Systems
  - d. 101-2009 – Life Safety Code
  - e. 731-2008 – Standards for the Installation of Electric Premises Security Systems
  - f. 99-2005 – Health Care Facilities

#### 1.4 SUBMITTALS

- A. In addition, to all submittal requirements as stipulated by Division 01 specifications sections, the Contractor shall provide all shop drawing submittals in accordance with the following:
  1. The Owner and Design Professional approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage, or installation of equipment or material which has not had prior approval will not be permitted at the job site.
  2. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings, and other data necessary for the Owner to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
  3. Submittals shall be provided as a complete submission, no partial submissions will be accepted. Failure to provide a complete submission shall result in all submittals being returned for resubmission.
  4. No substituted equipment shall be reviewed without prior approval in accordance with the requirements of “substitutions” under Division 1 specification section.
  5. Mark the submittals, "SUBMITTED UNDER SECTION \_\_\_\_\_".
    - a. Submittals shall be marked to show specification reference including the section and paragraph numbers.
  6. The Contractor shall schedule submittals in order to maintain the project schedule. For coordination requirements refer to Division 01 Specification Sections, which outline basic submittal requirements and coordination. All Division 01 Specification Sections requirements shall be used in conjunction with this specification section.
  7. Prior to any submission the contractor shall be responsible for performing the following quality control items to ensure compliance with all project requirements:
    - a. Review all Shop Drawings and Product Data
    - b. Review all field measurement criteria.
    - c. Review all field construction criteria and methodologies.
    - d. Review all catalog numbers and similar data.

- e. Review all coordination requirements of affected trades.
  - f. Review conformance to all appropriate specification sections.
8. All drawings shall be prepared using latest version of AutoCAD®, drawn accurately, and in accordance with the CAD Standards “CAD Standard Application Guide”. The Contractor shall not reproduce the Contract Documents or copy standard information as the basis of the technical data, hand drawn mark-ups of the original project drawings shall not be acceptable. Failure to provide a complete set of “contractor prepared” installation drawings at the time of submittal shall result in all submittals being returned for resubmission.
  9. The ESSI shall have a registered RCDD professional review and seal all system designs, installations and testing certification for all electronic security systems and associated structured cabling. Failure to provide RCDD sealed shop drawings shall result in all shop drawings being returned for resubmission without any reviews taking place.
  10. The Design Professional’s review of shop drawings and/or samples does not relieve the Contractor from compliance with all requirements of the project documents. No deviations from the project requirements shall be accepted unless the Contractor has informed the Owner and Design Professional in writing of any such deviations prior to the submission of shop drawings, has noted all deviations on the shop drawing submission, and the Owner and Design Professional has given written approval for the specific deviations to the project documents, otherwise all project requirements shall stand. The Owner and Design Professional’s review does not relieve the Contractor from any responsibility for delivering all criteria as stipulated by the contract documents because of errors, lack of clarity or omissions on the part of the Contractor in the review of shop drawings and/or samples by the Design Professional.
  11. Submit all system testing and startup procedures to be employed. Include all estimated times for performance of all tests, all test equipment and manpower necessary for testing.
  12. Submit all integrator qualifications, certifications and licenses in accordance with the requirements as specified elsewhere in this specification section.
  13. Submit project schedule outlining the time frames for all equipment with long lead times for equipment deliveries; include all system commissioning, testing and training time expectations. Project schedule shall be submitted as CPM schedule and shall utilize a software based project management program.

B. Shop Drawings:

1. All shop drawings shall include sufficient information, clearly presented, to determine full compliance with all project drawings and specifications. Include the following information for review, failure to provide all information listed below shall result in all shop drawing submittals being returned for resubmission:
  - a. All Building Floor and Site Plans
  - b. All equipment with manufacturer's name(s), model numbers,
  - c. All equipment /device electrical ratings and power requirements
  - d. All equipment /device performance ratings.
  - e. All standby battery and wiring voltage drop calculations
  - f. All surge and/or transient protection devices and device locations
  - g. All equipment rack, panels and cabinet layouts, rack/cabinet sizes.
  - h. All equipment and device-mounting elevations.
  - i. All device wiring details.
  - j. Complete point-to-point-wiring diagrams for all systems.  
Include all equipment and wiring termination schedules and programming matrixes.
2. Provide a complete set of “contractor prepared” installation drawings. All drawings at the minimum shall consist of floor plans indicating all device locations, device identifications, control panels, auxiliary control panels, power supplies, annunciation panels, conduit and cabling requirements as well as all 120 volt electrical circuit locations and designations.

- a. Drawings shall include at the minimum the following:
- 1) Detailed equipment layouts for all equipment rooms. Coordinate all room layouts with affected trades.
  - 2) Floor plan drawings showing locations of all control panels, sub-panels, ancillary controls, equipment cabinets and/or racks, annunciator panels, HMI terminals, auxiliary power supplies, devices and sensors, electrical power and grounding terminations as well as all device\sensor identifications
  - 3) Conduit routing of all conduits 2 inches in diameter or greater.
  - 4) System riser diagrams and single line drawings representing interconnections of all system control panels, sub-panels, ancillary controls, equipment cabinets and/or racks, annunciator panels, HMI terminals, auxiliary power supplies, devices, sensors and components, include all cable types and sizes, electrical power connections and circuits, grounding connections, surge and/or transient protection devices and all field device\sensor identifications.
  - 5) Block diagrams and Logic flow charts representing all systems architecture and interconnection of the security management systems (SMS) and fire management systems (FMS) all related integrated subsystems. Include detailed information on all system component integrations, data transmission and media conversions as well as logical functional data and performance criteria.
  - 6) Equipment wattage for all equipment room locations and estimated BTU production.
  - 7) Detailed equipment layouts for all equipment consoles. Indicate all equipment locations, power connections and installation details.
  - 8) All equipment mounting hardware/brackets and installation details, Identify type size, load capacities of all mounting hardware/brackets; include all mounting and installation details, all space requirements, any special architectural modifications required.
  - 9) Outline drawings of all equipment cabinets/racks showing the relative position of all major components, all-wiring and grounding terminations. Include all panel, cabinet and/or rack dimensions.
  - 10) Door Schedules for each door equipped with electronic security components. At a minimum, the door schedules shall be coordinated with Division 08 work and include the following information:
    - a) Door Number (Extracted from Architectural Drawings)
    - b) Door location on security floor plan drawing
    - c) Installation Details
    - d) Door Description (Extracted from alarm programming matrixes)
    - e) Data Gathering Panel Input Number
    - f) Door Position or Monitoring Device Type & Model Number
    - g) Lock Type, Model Number & Power Input/Draw (standby/active)
    - h) Card Reader Type & Model Number
    - i) Shunting Device Type & Model Number
    - j) Sounder Type & Model Number
    - k) Delayed Egress Type & Model Number
    - l) Intercom (video or standard)
    - m) Camera ID# associated with camera call-up (Extracted from alarm programming matrixes)
    - n) Type of Electric Transfer Hinge

- o) Electric Pass-through device
  - p) Remarks Column for Camera
- 11) Camera Schedules for all interior and exterior cameras.  
 Note: camera schedule shall be coordinated with the Owner and Design Professional for determination of camera numbers and naming conventions. At a minimum, the camera schedules shall include the following information:
- a) Camera Number
  - b) Camera Naming Convention
  - c) Description of Camera Coverage
  - d) Camera Location description
  - e) Camera location on Floor Plan drawings (include sheet and grid number)
  - f) Camera Type & Model Number
  - g) Mounting Type & Model Number
  - h) Installation Details
  - i) Cable Sizes, Types, Conductors, and Color
  - j) Power Input & Current Draw
  - k) Power Supply Location and electrical circuit number
  - l) Automatic Camera Call input (Extracted from alarm programming matrixes)
  - m) Remarks Column for Camera
3. All shop drawing submissions shall have a registered RCDD professional review and seal all shop drawings confirming that the proposed cabling infrastructures and terminations are in conformance with all stipulated standards and requirements as herein specified or in related specification sections.
4. Failure to provide all required documentation in accordance will ALL related specification requirements at the time of shop drawing submission shall result in all submittals to be returned for non-compliance to the contract requirements.

C. Equipment Submittals and Data Sheets:

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - a. Include all equipment data sheets pertinent to equipment provided. All data sheets shall be highlighted indicating specific equipment supplied. Failure to provide the proper annotation of all equipment shall result in submittals being returned for resubmission.
2. Submit complete technical data necessary to evaluate the material and equipment. Include a complete technical specification for the submitted equipment, noting differences and adherence to this Section. Failure to provide the required data will result in all submittals being returned for resubmission.
3. Submit performance data, equipment ratings, cable requirements, control sequences, GUI based control panels, programming matrixes, logic diagrams and all other descriptive data necessary to describe the installation and operations of the system being provided. Failure to provide the required data will result in all submittals being returned for resubmission.
4. Provide a complete termination schedule of all system devices, sensors, components, equipment and controls, identify all locations as indicated on the installation drawings, include all unique identification numbers which correspond with shop drawing floor plans.
  - a. Include point to point wiring terminations and programming matrixes for all readers and devices
  - b. All Documentation shall be provided in current version Microsoft Excel spreadsheets

5. Provide a clear and concise sequence of operation that gives, in detail, all information required to properly operate all equipment and systems. Include detailed programming matrixes, indicating at the minimum all manual and automatic functions for all system, components and devices comprising the system being provided.
  6. Provide copies of all preliminary graphic screens for all HMI configurations for this project. Graphic maps shall indicate all site plans, floor plan maps, utility screens, camera/monitor interface screens all door control functions, intercom activation's, alarm indications, door interlock functions and ancillary controls.
  7. Provide a listing of all recommended time zone and alarm shunting functions.
  8. Provide a preliminary list of all on screen emergency response instructions and help menus.
  9. Provide system parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.
  10. Failure to provide all required documentation in accordance will ALL related specification requirements at the time of shop drawing submission shall result in all submittals to be returned for non- compliance to the contract requirements.
- D. Maintenance and Operation Manuals: Submit in accordance with all requirements of Division 01 specification sections and as herein specified.
1. Maintenance and Operation Manuals shall be submitted for all systems and equipment specified in the technical sections. Furnish the number of copies as specified by Division 1, all manuals shall be bound in hardback binders, (manufacturer's standard binders) or an approved equivalent prior to the commissioning, testing and final acceptance of each system.
    - a. The Contractor shall also furnish one complete set of manuals as specified herein at the time of shop drawing submission for Design Professional s' use in the review of all submittals.
  2. Inscribe the following identification on the cover: "Maintenance and Operational Manual" include the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment.
    - a. The Maintenance and Operation Manuals at the minimum shall include:
      - 1) Copy of approved shop drawing and equipment submittals
      - 2) Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of all equipment, components, devices and servers.
      - 3) A complete control sequence describing start-up, operation, and shutdown of all equipment, components, devices and servers.
      - 4) Description of the function of each principal item of equipment.
      - 5) Installation and maintenance instructions
        - a) Safety precautions
        - b) Diagrams and illustrations.
        - c) Testing methods.
        - d) Performance data.
        - e) Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.

f) Appendix; list qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.

b. Failure to provide all required documentation in accordance with ALL related specification requirements at the time of shop drawing submission shall result in all submittals to be returned for non-compliance to the contract requirements.

## 1.5 QUALITY ASSURANCE

A. In addition to all general provisions of the Contract, including but not limited to all; General and Supplementary Conditions, Division 01 Specification Sections include the following project requirements:

1. Integrator Qualifications: The projects' Electronic Security System Integrator (ESSI) shall be an accredited and authorized distributor of the appropriate equipment manufacturer and shall be fully certified in the installation, testing and programming of all equipment being provided. The ESSI shall be a licensed security Contractor with a minimum of five (5) years' experience installing and servicing systems of similar scope and complexity.

a. The ESS integrator shall be capable of providing documented successful work experience of at least three (3) facilities of equivalent size and technical requirements utilizing the proposed equipment being provided. The system integrator shall have on staff a minimum of one full time individual that holds a current RCDD registration.

1) All electronic security systems and related work shall be certified in writing to the Owner and Design Professional by a RCDD professional asserting that all electronic security system shop drawings and all associated structured cabling is in conformance with all appropriate NEC requirements, EIA/TIA standards; NFPA 731 recommended practices, BICSI recognized installation practices and all related specification sections.

2. Cable Installer Qualifications: The cable installation contractor shall demonstrate not less than three (3) years' experience in the installation of structured cabling systems and shall have on staff a minimum of one full time member that holds a current BICSI level II installer credential.

a. NOTE: The installation of all cabling shall be under the direct supervision of a current BICSI level II installer who shall be knowledgeable in the following technical applications:

1) The Routing and installation of shielded, unshielded, twisted pair, coaxial and fiber optic cables.  
2) Generally accepted industry standards, as well as manufacturers written installation instructions, will be used for in-process quality control and final acceptance of the work installation.

b. Provide registration number and expiration date of BICSI level II installer assigned to the project.

3. The Owner and Design Professional reserve the right to require the Contractor to submit a list of installations where the products have been in operation before approval of shop drawings.



- a. Experience shall be defined as the completion of the specific system being provided, with that system being successfully operated by the Owner for its intended purpose for at least three (3) years.
  - b. In addition to the above "Experience" shall also be defined as the completion of modifications and renovations to any associated system being provided in any existing occupied facility of this size and magnitude.
  - c. For each facility submit the following:
    - 1) Name and location of facility.
    - 2) Date of Occupancy or beneficial use by Owner.
    - 3) Owner's representative to contact and telephone number.
    - 4) Construction Manager or General Contractor.
    - 5) Project Architect or Engineer.
    - 6) Provide detailed information on the installed locations with operational equipment.
4. Service Qualifications: The ESSI shall be a permanent service organization maintained and/or trained by the product manufacturer on the products being provided for this project.
- a. The integrator shall be properly licensed by the governing municipality (where required) certified to provide the services and work of the specific system being provided.
  - b. In addition, all integrators shall be capable of providing full service for the entire warranty period within an 8-hour response time upon notification of a service emergency.
  - c. Provide registration number and expiration date of RCDD professional.
5. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and materials specified for this project, and shall have manufactured the items for at least three years.
- a. Product Qualification: The Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
  - b. The equipment manufacturer shall submit the appropriate documentation certifying that the project integrator is a qualified service provider and certified in the installation and programming of all manufacturers' products being provided for this project.

## 1.6 RECORD DOCUMENTS

- A. In addition to all general provisions of the Contract, including but not limited to all; General and Supplementary Conditions, Division 01 Specification Sections include the following project requirements.
  - 1. Provide complete set of finalized copies of record documents prior to final acceptance of the project by Owner and Design Professional in accordance with all requirements of Division 01 specification sections. At the minimum the record documents shall contain all information, data and drawings as described in Chapter 1.4 "Submittals" of this specification section.
    - a. As-built documents shall be submitted in both paper and electronic media formats in the quantities as specified by Division 1 specification requirements.
      - 1) All electronic record drawings shall be prepared and submitted utilizing an AutoCAD based program as manufactured by Autodesk. Where electronic documents are prepared using other than an AutoCAD program

manufactured by Autodesk, the contractor shall provide to the Owner and Design Professional the necessary software to electronically view the submitted documents.

- 2) All electronic data sheets, control sequences, programming matrixes and other descriptive data shall be provided in PDF format.
- 3) Copies of all current system programming and associated software shall be provided on downloadable media formatted for the use in restoration all system operations and functionality in the event of a catastrophic failure.

## 1.7 SOFTWARE AGREEMENT

- A. Included as part of the scope of work for this project the Owner shall retain the ownership and access rights of ALL system programs and software associated with all systems installed and/or modified as part of this project.
  1. The contractor shall provide to Owner complete copies of all current software programming and software licenses related to the operation of each system prior to final acceptance of the related Contract scopes of work.
    - a. All programming shall include but not be limited to all device identifications, device descriptions, Programming Logic Matrixes, all program access level passwords as well as all function and sub-function routines.
  2. Programming and software copies shall be provided to the Owner on CD or DVD digital formatted media. In addition, the contractor shall provide a complete hard copy printout of all system programming and shall be included as part of closeout documentation for review by the Owner and Design Professional.
- B. Software and firmware upgrade provisions shall be included as part of this specification requirement and shall include the automatic upgrades as required to maintain all software and firmware to the manufacturers most current revision on all system components installed and or modified as part of this project for duration of the warranty period. This upgrade policy shall require the contractor to install, test and certify all software and firmware upgrades that become available from manufacturer for a period of one year from date of final acceptance to the expiration of the warranty.
  1. Upgrading of software shall include all revised/new software, labor, testing certification as well as all licenses, software and all programming copies as described in Chapter 1.6 of this section associated with the installation of all revised software.
  2. These updates shall be accomplished in a timely manner, fully coordinated with the system operators, and incorporated into the operations\maintenance and software documentation manuals.
    - a. One (1) scheduled final update shall be provided near the end of the warranty period, at which time the Contractor shall install and validate the latest released version of the Manufacturer's software and firmware for all systems installed and/or modified for this project.
    - b. All software changes shall be recorded in a log maintained in the unit control. An electronic copy of the most current software update shall be maintained within the log.
      - 1) At a minimum, the contractor shall provide a description of the modification, when the modification occurred, and name and contact information of the individual performing the modification. The log shall be maintained in a white 3 ring binder and the cover marked "Software Change Log".

3. Provide not less than thirty days' notice to the Owner and Design Professional to allow scheduling and access to system and to allow the Owner to upgrade computer equipment if necessary.

## 1.8 EXTRA MATERIAL

- A. In addition to all general provisions of the Contract, including but not limited to all; General and Supplementary Conditions, Division 01 Specification Sections refer to related specification sections "Extra Material" for specific requirements.
- B. All Extra materials shall be provided at the time of final acceptance of the project and a signed packing list shall be obtained at the time of delivery. At no time is the contractor to use the extra materials provided for this project to replace malfunctioning or damaged equipment and or components.
- C. Provide 5% of all material as " Extra Material."

## PART 2 – PRODUCTS

### 2.1 MANUFACTURED PRODUCTS

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, that meet and/or exceed the specified performance and features of the equipment and/or systems and for which replacement parts shall be readily available to the system integrator and/or using agency.
  1. When more than one unit, device or component of the same class of equipment is required, such units, devices or components shall be the product of a single manufacturer.
  2. Acceptable manufacturers for each system shall be as specified and shall be provided in full compliance with the requirements of this and all related specification sections and contract drawings.
    - a. Manufacturers listed as acceptable shall not negate the contractors' responsibility for providing all equipment, devices, components and/or systems, in accordance with all functions and performance requirements of the Contract Documents.
    - b. Where manufacturer and/or manufacturer model numbers reference specific system components in the related specification sections, it is to establish the performance requirements and quality of the systems and components only.
      - 1) It is in no way an inference that the referenced model numbers are the manufacturer's current product and are the only acceptable components for this project unless specifically referenced as "no substitutions".
    - c. The Contractor shall provide the manufacturers' most current product that shall meet and/or exceed the specified performance and features of the equipment and/or systems.
    - d. Equivalent UL- listed equipment may be substituted for the approved manufacturers unless stipulated by other specification sections as "No Substitutions". All substitutions shall be submitted for approval by Owner and Design Professional in accordance with all requirements of Division 01 specification sections and Chapter 1.4 "Submittals" of this specification section.
      - 1) Where systems and/or components are referenced as "no substitutions" the specific system and/or components shall be provided.

- 2) All substitutions shall comply with all requirements as specified above and all system performance standards shall be maintained.
- 3) The contractor shall stipulate the following information impacted by such a substitution.
  - a) Any and all extensions in time impacted by the substitution.
  - b) Any changes to the architectural or structural elements to the project
  - c) Differences in operation and/or performance from intended system criteria.
- 4) Failure to provide the required substitution information shall result in "without consideration" the immediate rejection of the substituted equipment and/or systems.

B. Equipment Assemblies and Components:

1. Components of an assembled unit need not be products of the same manufacturer.
  - a. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
  - b. Components shall be compatible with each other and with the total assembly for the intended service.
  - c. Constituent parts which are similar shall be the product of a single manufacturer.
  - d. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.

C. Where Factory or Off-Premises Testing of any equipment, product or assembly is recommended by the product manufacturer or where specified as part of this section and/or any related specification section:

1. The Owner and/or Owner representatives shall have the option of witnessing all factory tests. The Contractor shall notify the Design Professional at a minimum of thirty (30) working days prior to the performance of any factory or off-premises tests.
  - a. Where the factory or assembly point for all off-premises testing is not within two (2) hours driving time from the project location, the ESSI shall include as part of this project all per diem costs (travel, meals and lodging) for a minimum of two representatives of the using agency and the project Design Professional to witness all testing.
2. Provide four (4) copies of certified test reports containing all preliminary test data and testing procedures shall be furnished to the Owner and Design Professional prior to any final testing and not more than ninety (90) days after completion of any tests.
3. When equipment, product or assembly fails to meet any factory or off-premises tests, retesting of equipment, product or assembly shall be mandated, the manufacturer/integrator shall be liable for all additional expenses, including all expenses incurred by the Owner and Design Professional for witnessing the retesting of any equipment, product or assembly.

## PART 3 – EXECUTION

### 3.1 EQUIPMENT PROTECTION

- A. Protect all materials, equipment, devices or components permanently installed and/or stored on the job site. Protect all materials, equipment, cabling, devices or components during construction and after installation, provide appropriate protection of all materials, equipment, components and/or devices until time of substantial completion. All materials, equipment, components and/or

devices shall be protected during shipment and storage against any physical damage, dirt, moisture, cold, snow or rain:

1. During installation, enclosures, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected against entry of any foreign matter; and shall be vacuum cleaned both inside and outside before testing and operating and repainting if required.
  2. Any materials, equipment, components and/or devices, stored on site which have been deemed by the Design Professional to exhibit any indications of damage or exposure dust or moisture shall not be installed and shall returned to the source of supply for immediate replacement.
    - a. The use of spare parts or the return of defective equipment for repair to mitigate the damage of defective materials, equipment, components and/or devices shall not be acceptable. All materials, equipment, components and/or devices shall be new and unused until final acceptance by the Design Professional.
  3. Provide and apply protective material immediately upon receiving the products and maintain throughout the construction process.
    - a. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
    - b. Any damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas is not obvious or detectable.
  4. Failure to properly protect all materials, equipment, components and/or devices prior to final acceptance shall constitute sufficient cause for rejection of materials, equipment, components and/or devices should any defects, damage or degradation in performance is observed.
- B. Immediately replace all malfunctioning materials, equipment, components and/or devices with new unused products up until the time the Design Professional issues final acceptance of the system. The returning of any malfunctioning equipment, devices and/or components to the manufacturer for repair and then reinstallation at the project site shall not be acceptable.
1. All replacement materials, equipment, components and/or devices shall be factory new and not scavenged from the Project's spare parts inventory or factory recycled products unless expressly identified by contractor prior to replacement and approved beforehand by the Design Professional.

### 3.2 WORK PERFORMANCE

- A. Installation, final termination, testing, start-up and commissioning of all systems, system components and cabling infrastructures shall be under the direct supervision of the appropriate system integrator. The integrator shall be an accredited and authorized distributor of the appropriate equipment manufacturer and shall be fully certified in the installation, testing, commissioning and programming of all equipment, devices, components and/or systems being provided as part of this project.
- B. Job site safety and worker safety is the responsibility of the contractor. Ensure that safe access and egress from all work areas is maintained during movement and installation of materials. Clean up all debris generated by installation activities. Keep all security electronic equipment rooms free of debris at all times.

- C. Pre-installation Conferences: Include provisions to attend all pre- installation conferences at Project site in compliance with all requirements in Division 01 specification section and as herein specified. Review methods and procedures related to installation and operations of all safety and security systems, including, but not limited to, the following:
1. Inspect and discuss electrical and control system roughing-in related to all safety and security systems as well as other preparatory work required to be performed by other trades.
  2. Review sequence of operations for each type of system, controls and/or integration to any systems and/or equipment provided by other trades
  3. Review and finalize construction schedule and verify availability of materials, installation personnel, equipment, and any preparatory work by other trades needed to make progress and avoid delays.
  4. Review required start-up, testing, commissioning and certifying procedures to be employed for each system and any impacts to other trades.
- D. For work on existing facilities, arrange, phase and perform work to assure the operation of all security systems for other buildings and contiguous spaces at all times. Refer to Division 1 specification section for additional information.
- E. All new work shall be installed and connected to existing work neatly and carefully. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Division 1 specification sections.
- F. Coordinate the installation of all cabling, conduits/raceways and cable trays and equipment with applicable trades to ensure proper operation and function of all integrated systems in accordance with all related specification sections. Refer to Division 1 specification section for additional project coordination requirements.
1. Coordinate with all trades at the time of shop drawing submission detailing all space and/or room conditions. The contractor shall coordinate with the appropriate trade all conditions impacting the installation of any system including but not limited to all equipment locations, ceilings, lighting fixtures, fire protection piping and ductwork layouts to the satisfaction of all concerned trades, subject to final review by the Design Professional.
    - a. Coordinate exact location of all desktop/counter/wall mounted equipment with the Owner and Design Professional and affected trades prior to the installation of any equipment and/or cabling.
    - b. Coordinate exact location(s) of all ceiling mounted cable, conduits, equipment and/or devices with all architectural plans, reflected ceiling plans and affected trades prior to installation.
    - c. Equipment installations requiring coordination with other trades the contractor shall provide all templates, back-boxes and equipment anchor bolts for mounting or flush mounting preparation, (e.g. pedestals or other devices requiring mounting on walls, concrete pads or other materials). Coordinate delivery of templates and equipment anchor bolts to preclude any delay in the construction schedule or the work of the affected trade.
    - d. If installation of equipment, devices, cabling, raceways, cable trays and/or conduit is performed prior to coordination with other trades, which interferes with work of other trades or operation and maintenance of the facility, make necessary changes to correct the condition at no additional cost to the Owner.
    - e. Prior to the final programming of any systems review with Owner and Design Professional all system features, functions, system operations, network mapping, system integrated responses and all related programming as required for the proper operation of the respective security systems.

- G. The Contractor shall maintain a complete set of current and up to date set of shop drawings and equipment submissions at the job site at all times. The Shop drawings and all other submissions shall be marked up to reflect all as-built conditions and shall be made available for review by the Design Professional at request.

### 3.3 EQUIPMENT/CABLE INSTALLATION AND REQUIREMENTS

- A. All system wiring and equipment installation shall be in accordance with good engineering practices and by all IEEE, TIA, NEC and manufacturer's requirements. Wiring shall comply with all state and local electrical codes. All wiring shall test free from all grounds, shorts, stray voltages and EMI.
- B. Follow manufacturers' instructions for installing, components and adjusting all equipment and cabling. Submit two (2) copies of such instructions to the Design Professional before installing any equipment. Provide a copy of such instructions at the equipment during any work on the equipment. Where no instructions are included with the equipment, follow accepted industry practices and workmanlike installation standards.
- C. Ensure that all security and video, systems cabling supports (conduits, support grips, cable tray and J-hooks) are fully installed before proceeding with cable installation. At no times shall any cables be installed and left unsupported. At no times shall cables be tie-wrapped to any other supporting structure in lieu of specified cable supports. Do not bundle or tie-wrap the cables even within the approved cable supports.
  - 1. Do not leave any system cabling unprotected on the floor at any time. If cables must be left on any floor, protect the cables so that they may not be walked on or have any material or equipment placed or rolled on top. Replace all damaged cables from demarcation to termination point; no splicing of damaged cables shall be permitted.
  - 2. Maintain manufacturers recommended minimum bend radiuses of all cabling. Do not stretch, stress, tightly coil, bend or crimp the backbone, horizontal, patch or workstation cables. The Contractor shall keep all cabling out of the way of other trades during staging of any work. The contractor at the contractor's expense will replace all severely stressed or damaged cables, equipment and materials as determined by the Design Professional.
- D. Equipment location shall be as close as practical to locations as indicated on the contract drawings.
  - 1. Provide all equipment clearances in accordance with NEC requirements. Arrange equipment to facilitate unrestricted access for maintenance and service around all equipment, components and/or cable terminations.
- E. Inaccessible Equipment:
  - 1. Where the Design Professional determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the project.
    - a. "Conveniently accessible" is defined as being capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.
- F. Cabling Requirements

1. Contractors shall have the option to combine all home runs and conductors of same type and voltage "class" in accordance with NEC requirements unless specified elsewhere. Size all conduits and install all conductors in accordance with NEC requirements and manufacturers recommendations.
  - a. All TCP/IP based security system cabling is to be Category-6 and concealed above suspended ceilings, bundled and supported to the building structure. All cabling bundles shall be plenum rated and shall not contain any AC carrying conductors or non-associated security network cables. All TCP/IP based security cabling located above accessible suspended ceilings may be installed without conduit and shall be supported by "J" hooks.
    - 1) Cabling installed above inaccessible ceiling spaces shall be installed in dedicated conduits.
    - 2) No exposed cabling will be acceptable in finished or occupied spaces of the facility without approval by the Owner and Design Professional.
    - 3) Any CCTV, intercom or PACS system cabling installed exterior to the building and/or all cabling being routed from the facility to any remote location external to the project location shall be installed in fiber optic cable.
    - 4) Refer to related specification sections for additional information for additional information related to cabling types, sizes and testing requirements.

#### G. Environmental Conditions

1. Systems, components, devices materials and equipment shall be capable of withstanding the environmental conditions of the space without mechanical or electrical damage or degradation of operating capabilities or performance.
  - a. Interior, Controlled Environment: System components, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient conditions of 2 to 50 deg C (36 to 122 deg F) dry bulb and 20 to 90 percent relative humidity, non-condensing and shall utilize NEMA 250, Type 1 enclosures.
  - b. Interior, Uncontrolled Environment: System components installed in non-temperature-controlled interior environments shall be rated for continuous operation in ambient conditions of -18 to 50 deg C (0 to 122 deg F) dry bulb and 20 to 90 percent relative humidity, non-condensing and shall utilize NEMA 250, Type 4X enclosures.
  - c. Exterior Environment: System components, conduits and back-boxes installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of -34 to 50 deg C (-30 to 122 deg F) dry bulb and 20 to 90 percent relative humidity, condensing. Rated for continuous operation where exposed to rain as specified in NEMA 250, winds up to 137 km/h (85 mph) and snow cover up to 610 mm (24 in) thick shall utilize NEMA 250, Type 4X enclosures.
  - d. Hazardous Environment: System components, conduits and back-boxes located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
  - e. Corrosive Environment: System components, conduits and back-boxes subjected to corrosive fumes, vapors, and wind-driven salt spray in coastal zones, shall utilize NEMA 250, Type 4X enclosures.
  - f. Submersible Environment: System components, conduits and back-boxes subjected to prolonged submersion in water, shall utilize NEMA 250, Type 6P enclosures.
  - g. Areas where equipment and devices may be subject to damage by the general population shall be installed in vandal resistant enclosures, all fire alarm devices shall be provided with wire guards.



- h. Console: All console equipment shall, unless noted otherwise, be rated for continuous operation under ambient environmental conditions of 15.6 to 29.4 deg C (60 to 85 deg F) and a relative humidity of 20 to 80 percent.

H. Conduits/raceway/Cable Trays:

- 1. All conduits/raceways shall be concealed and shall be installed above accessible finished ceilings and/or in walls. Any conduits/raceways installed in areas requiring installation to be exposed, shall be installed tight to ceilings at right angles to walls and shall not obstruct any access hatches, equipment service panels, lighting or other equipment and/or devices. No exposed conduits/raceways shall be installed without prior approval of the Design Professional prior to installation.
  - a. All raceways shall be supported in accordance with NEC requirements and shall be affixed in such a manner that tampering and/or removal by the general population without the use of specialized tools shall be prevented.
  - b. Outlet Boxes: shall be 4 x4 x 2-1/8 inches deep for all data jack locations and single gang for wall mounted telephone locations.
    - 1) All outlet boxes shall be provided with single or dual gang device mud-rings flush to finished wall as required based on type and configuration of outlet and type of wall construction.
    - 2) Use deep masonry boxes at masonry construction. T-Bar hangers or other appropriate mounting hardware shall be utilized to support boxes mounted in the ceiling.

I. Penetrations of Walls and Floors

- 1. All wall/floor penetrations are to be sleeved and fire stopped with approved fire stopping material. Coordinate all cable and conduit penetrations of the structure with all trades.
  - a. All penetrations of walls and floors shall be fire stopped in accordance with the ASTM and NFPA standards. Refer to related specification sections for additional information.
  - b. Floor penetrations shall be sleeved with a minimum sleeve diameter of 4 inches. An additional penetration shall be provided for future use, sleeved and capped and fire stopped as required.
  - c. Coordinate size of wall penetration with conduit size, number of conductors. Comply with all NEC requirements.
  - d. The fire rating of all penetrated walls, floors, and ceiling structures shall be strictly maintained. All penetrations shall be fire-stopped and sealed by the Contractor.
  - e. Install fire-stopping in open penetrations and in the annular space of penetrations for fire rated barriers.
  - f. Installation of fire-stops shall be performed by an applicator/installer qualified and trained by the manufacturer. Installation shall be performed in strict accordance with manufacturer's detailed installation procedures.
  - g. Installation of all fire-stopping shall be in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer's recommendations, local fire and building authorities, and applicable codes and shall be installed in a manner acceptable to the authority having jurisdiction.

- J. Transient Voltage Surge Suppression: All cables and conductors extending beyond building façade, except fiber optic cables, which serve as communications, control, or signal lines shall be protected against Transient Voltage surges and have Transient Voltage Surge Suppression (TVSS) protection.

1. The TVSS device shall be UL listed in accordance with Standard TIA 497B installed at each end. Lighting and surge suppression shall be a multi-strike variety and include a fault indicator.
2. Protection shall be furnished at the equipment and additional triple solid state surge protectors rated for the application on each wire line circuit shall be installed within 914.4 mm (3 ft) of the building cable entrance. Fuses shall not be acceptable for surge protection applications. All inputs and outputs shall be tested in both normal mode and common mode to verify there is no interference at the minimum surge suppression test shall meet the following criteria.
  - a. All system power supplies serving exterior system components or devices shall be provided with the appropriate transient surge suppression protection on both the line side as well as the load side.
    - 1) A 10-microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 volts and a peak current of 60 amperes shall be the minimum performance requirements. Provide surge suppression in accordance with all manufacturers requirements.
    - 2) An 8-microsecond rise time by 20-microsecond pulse width waveform with a peak voltage of 1000 volts and a peak current of 500 amperes shall be the minimum performance requirements. Provide surge suppression in accordance with all manufacturers requirements.
    - 3) Maximum series current: 2 AMPS. Provide units manufactured by Advanced Protection Technologies, model #TE/FA 10B or TE/FA 20B or approved equal.
    - 4) Operating Temperature and Humidity: -40 to 85 deg C (-40 to 185 deg) shall be the minimum performance requirements. Provide surge suppression in accordance with all manufacturers requirements.

### 3.4 GROUNDING AND BONDING

- A. All electronic equipment, conduits, cable trays, racks/cabinets and cable shields shall be properly grounded and bonded in accordance with all requirements of TIA 607-D, NEC 250 and IEEE 1100.
  1. All grounding connections shall provide the equalization of all grounding potentials between the building power system and the grounding terminations at the security equipment in order to provide the diversion of electrical transients as well as providing the necessary coupling in order to cancel and/or reduce any voltage transients.
    - a. Equipment Grounding: Metallic structures, equipment racks, cabinets and enclosures as well as all raceways, cable trays, junction boxes, outlet boxes, machine frames, and other conductive items shall be bonded and grounded.
  2. All connections of grounding conductors to ground rods, bus bars, rebar, structural members, pipes and fences, as well as splices of any ground conductors, shall be made by exothermic welds except where otherwise noted. All connections to bar lugs shall be exothermic weld or compression type connections. Bolted type connection of ground conductors may only be made where terminal lugs or blocks have been furnished and installed in equipment by the manufacturer.
    - a. Equipment grounding conductors shall be insulated stranded copper, except for sizes No. 10 AWG and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes No. 4 AWG and larger shall be permitted to be identified per the NEC.

- 1) At the minimum bonding connection shall be a #6 AWG copper conductor. All grounding shall provide an effective bonding connection between the protected equipment to the nearest approved building grounding electrode (structural steel) as well as to the local power distribution panel grounding system (e.g., ac branch circuit panel board's equipment grounding busbar). All bonding and grounding connections shall be NEMA type compression or exothermic welded connections.
3. Refer to related specification sections for any additional grounding and bonding requirements.

### 3.5 EQUIPMENT IDENTIFICATION

- A. Identify all system controls, components and equipment cabinets using plastic laminate engraved labels, or approved equal. Firmly affix to the panel, device and/or component.
  1. Nameplates shall be laminated black phenolic resin with a white core with engraved lettering, a minimum of 6 mm (1/4 inch) high. Secure nameplates with screws. Nameplates that are furnished by manufacturer as a standard catalog item or where other method of identification is herein specified. Dymo or Kroy tap adhesive backed lettering shall not be acceptable.
  2. Color-code all junction boxes and enclosures per NEC recommendations. At the minimum provide all security junction boxes as follows:
    - a. Color for Security circuits - Orange.
    - b. Color for CCTV circuits - Green
    - c. Color for Fire - Red.
    - d. Letter all pull boxes and junction boxes located in service area tunnels, above accessible ceilings and pipe chases with laminated black phenolic resin with a white core with engraved lettering, a minimum of 6 mm (1/4 inch) high. Secure nameplates with screws.
      - 1) Example: Security system "SS," Circuit Number SS-126.  
Engraved laminated plastic tags shall be used for identification and securely fastened in accordance with the project requirements.
  3. Permanently label all wiring at both ends with self-adhering plastic labels.
  4. Provide typewritten circuit directories installed in 3-ring binders with transparent page protectors in each control and sub control cabinet and/or equipment rack.

### 3.6 MAINTENANCE & SERVICE

- A. General Requirements
  1. The Contractor shall provide all services required and equipment necessary to maintain the electronic security systems in an operational state as specified after formal written acceptance of the system.
    - a. Provide all necessary material required for performing scheduled adjustments or other non-scheduled work. Impacts on facility operations shall be minimized when performing scheduled adjustments or other non-scheduled work. Refer to Division 1 specification section for additional information.
    - b. The adjustment and repair of the security systems shall include all software and firmware up-dates on all computers, CPU's, HMI terminals, devices, communications and data transmission medias' (DTM), facility interface processors, signal transmission equipment, video surveillance and security

management software and processors.

- c. Test, inspect and service each system on a quarterly basis at three month intervals during the warranty period from the time of final acceptance. The contractor shall compare each three month test results with the test results at the time of final acceptance.
  - 1) The contractor shall include as part of the quarterly test the calibration and/or adjustment of any device, component and/or system that has deviated from the original test results at the time of final acceptance.
- d. For each quarterly maintenance period, provide written notification to the Owner of the systems condition before and after service, the exact components that were tested and serviced, and overall status of the system.

#### B. Personnel

1. Service personnel shall be manufacturer certified in the maintenance, testing and repair of the type of system and equipment provided for the project. Provide the Owner and Design Professional the name of the designated service representative, and of any change in personnel. The Owner and Design Professional shall be provided copies of system manufacturer certification for the designated service representative.
  - a. Schedule of work to be performed during regular working hours, Monday through Friday, excluding federal holidays.

#### C. Emergency Service

1. The Owner shall initiate service calls whenever the system is not functioning properly. The Contractor shall provide the Owner with an emergency service center telephone number. The emergency service center shall be staffed 24 hours a day 365 days a year. The Owner shall have sole authority for determining catastrophic and non-catastrophic system failures.
  - a. For catastrophic system failures, the Contractor shall provide same day eight (8) hour service response with a defect correction time not to exceed sixteen (16) hours from [notification] [arrival on site]. Catastrophic system failures are defined as any system failure that the Owner determines will place the facility(s) at increased risk.
  - b. For non-catastrophic failures, the Contractor within 1 business day with a defect correction time not to exceed 48 hours from time of notification.

#### D. Records & Logs

1. The Contractor shall maintain records and logs of each task and organize cumulative records for each component and for the complete system chronologically. A continuous log shall be submitted for all devices. The log shall contain all initial settings, calibration, repair, and programming data. Complete logs shall be maintained and available for inspection on site, demonstrating planned and systematic adjustments and repairs have been accomplished for the system.

#### E. Work Request

1. The Contractor shall separately record each service call request, as received. The record shall include the serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing the action taken, the amount and nature of the materials used, and the date and time of commencement and completion. The Contractor shall

deliver a record of the work performed within five (5) working days after the work was completed.

F. System Modifications

1. The Contractor shall make any recommendations for system modification in writing to the Design Professional. No system modifications, including operating parameters and control settings, shall be made without prior written approval from the Design Professional. Any modifications made to the system shall be incorporated into the operation and maintenance manuals and all related documentation.

3.7 WARRANTY

A. Warrant material and workmanship for a period as specified in Division 1 of the contract documents and all related specification sections. The warranty period shall commence from the date the Contractor received written notification of final acceptance from the Design Professional. At the minimum the contractor shall provide warranty provisions:

1. Warrant the replacement of defective components/materials and/or correct defective work when given notice by the Owner during the warranty period.
2. Warranty excludes liability for consequential incidental, or special damages due to vandalism, misuse, or acts of God.
3. Onsite warranty response time by qualified technician shall be within 8 hours upon receipt of request from Owner.
4. Warranty repairs shall be provided to the Owner at no cost. This shall include but not limited to all repairs and/or replacement of defective components/materials, all labor charges, all travel costs and all vehicle charges.
5. Response time shall be 7 days a week / 24 hours a day / 365 days a year.
6. Provide test, inspection and service of each system on a quarterly basis at three month intervals.
7. Contractor must provide verification that they maintain their principal base of operation along with the personnel that will be responsible for providing service within 3 hours driving time to the project site. This tenet of the warranty shall remain in effect for the life of the warranty.
8. All TCP/IP based security communications cabling and related appurtenances shall be provided with the manufacturers 25 year extended warranty in addition to all requirements above.

B. The Contractor shall, as a condition of final payment, execute a written warranty certifying all contract requirements have been completed according to all requirements of the Contract Documents.

1. All system testing, commissioning, demonstration and training shall be performed prior to final system acceptance. All defects or damages due to faulty materials or workmanship shall be repaired or replaced without delay, to the satisfaction of the Owner and Design Professional, at the Contractor's expense.
  - a. The contractor shall provide written documentation of test results and stating what was done to correct any deficiencies. The first inspection shall occur 90 calendar days after the acceptance date. The last inspection shall occur 30 calendar days prior to the end of the warranty.
  - b. The warranty period shall be extended until the last inspection and associated corrective actions are complete. When equipment and labor covered by the Contractor's warranty, or by a manufacturer's warranty, have been replaced or restored because of its failure during the warranty period, the warranty period for any replaced or repaired equipment or restored work shall be reinstated for a period equal to the original warranty period, and commencing with the date of

completion of the replacement or restoration work.

2. In the event any manufacturer customarily provides a warranty period greater than one (1) year, the Contractor's warranty shall be for the same duration for that component.

### 3.8 FIELD SERVICES

#### A. Notify Owner and Design Professional in writing, ten days advance of testing of all system cabling to prevent delays in construction schedules.

1. Test all cabling to confirm that no grounds, shorts, sneak currents, RFI and EMI conditions exist prior to start-up and commissioning of all, components, devices, equipment and/or systems.
  - a. Before requesting a final inspection, the Contractor shall perform a series of end to end installation performance tests. The Contractor shall submit for approval by Design Professional all test procedures to be employed, test result forms, and timetable for testing all fiber optic and copper plant wiring.
  - b. Acceptance of the simple test procedures discussed below is predicated on the Contractor's use of the recommended products including but not limited to twisted pair cable, cross-connect blocks, and outlet devices specified and adherence to the inspection requirements and practices set forth. Acceptance of the completed installation will be evaluated in the context of each of these factors.
2. Perform all tests, as required, by authorities having jurisdiction throughout the facility.
3. Testing of all electronic security systems shall be in the presence of the Owner and Design Professional as well as all appropriate representatives of the authorities having jurisdiction.
  - a. All completed the security systems shall be fully tested in accordance with all requirements of NFPA 731. Upon completion of a successful testing, the contractor shall so certify in writing to the Owner and Design Professional that all testing was completed, certified and left in first class operational condition, include all completed NFPA 731 certification and test reports.
  - b. The service of a competent, factory-trained engineer or technician authorized by the equipment manufacturer shall be provided to technically supervise installation and participate during initial system programming, start-up, final testing, assist in the final acceptance testing and Owner demonstrations.
  - c. At the minimum all acceptance testing, demonstrations and training shall include, but not be limited to the following:
    - 1) Security Monitoring/Control Systems
    - 2) CCTV Surveillance System Performance and Functions
    - 3) Remote Security Monitoring/Control Systems
    - 4) CCTV Surveillance System programming and configurations
    - 5) UPS and Battery Back-up Functions.
    - 6) Integration of all Auxiliary Systems
4. In addition, provide all testing, commissioning and certifications as specified by Division 1 specification sections and any manufacturer's recommendations or requirements.

#### B. Training

1. In addition to all demonstration and training as specified by Division 1 specification section and all related Division 28 specification sections, system demonstrations and training shall

- be provided in accordance with all requirements of this section.
2. Prior to acceptance of the work, the System Integrator shall demonstrate to the Owner and Design Professional, all systems and sub-systems all features and functions of each system and shall instruct the Owner Representatives in the proper operation, event sequences, programming and maintenance of all systems and sub-systems.
  3. The System Integrator shall furnish the necessary trained personnel to perform all demonstrations and instructions and arrange to have the manufacturer's representatives present to assist with the demonstrations.
  4. Training time shall include, as a minimum, the total time determined by the sum of the times per system as specified in this and related specification sections, for performing the prescribed demonstrations/training. Refer to related specification sections for additional training requirements.
    - a. Allow a minimum of 16 hours' time for each system provided for performing the prescribed demonstrations/training.
      - 1) Provide a minimum of (4) four 4-hour training classes performed at the project location and spaced over a three week interval. Training classes shall be scheduled not less than 48 hours apart to allow the Owner User\Operators to familiarize themselves with all system operations.
  5. Provide operation, parts and maintenance manuals defining operation and troubleshooting methods of all systems and review with Owner User\Operators as part of training demonstrations.
  6. Provide detailed video recordings in high quality digitally formatted media of all demonstration and training of all systems and system operations.
    - a. Utilize remote microphones as may be required to ensure high quality audio of the recorded demonstrations.
    - b. Permanently and professionally label all recorded materials and provide self-sealing plastic cases.

C. Inspections

1. At the completion of the project and prior to final acceptance of the Work, provide evidence of final inspections and approvals to the Owner and Design Professional, as required by the authorities having jurisdiction as well as all requirements of Division 01 specification sections.

END OF SECTION

SECTION 281300

ACCESS CONTROL

PART 1 - GENERAL

1.1 STIPULATIONS

A. Project drawings and general provisions of the Contract, including but not limited to all; General and Supplementary Conditions, Division 01 Specification Sections and all stipulated Specification Sections shall apply to this and all related Division 27 specification sections.

B. Related Sections:

1. Division 07 – Through-penetration Firestop Systems
2. Division 26 – Common Work Results for Electrical
3. Division 26 – Low Voltage Electrical Power Conductors and Cables
4. Division 26 – Grounding and Bonding for Electrical Systems
5. Division 26 – Hangers and Supports for Electrical Systems
6. Division 26 – Raceways and Boxes for Electrical Systems
7. Division 26 – Identification for Electrical Systems
8. Division 27 – Common Work Elements for Communications Systems
9. Division 27 – Network Communications Systems
10. Division 27 – Network Hardware
11. Division 27 – Two-Way Communications System
12. Division 27 – Audiovisual Systems
13. Division 28 – Common Work Elements for Electronic Safety and Security
14. Division 28 – Access Control
15. Division 28 – Video Surveillance System

C. Reference Symbols:

1. All device symbols are defined by the appropriate symbol schedules. Because of the scale of the drawings, symbols are shown on drawings as close as possible to the mounting location.
  - a. Contractor shall coordinate exact locations with all architectural drawings, site plans, reflected ceiling plans, furniture plans, mechanical and electrical drawings as well as all affected trades prior to submittal of any shop drawings.

D. Abbreviations:

1. Refer to Specification Section 28 05 00 for additional information.

E. Definitions:

1. Refer to Specification Section 28 05 00 for additional information.

1.2 SUMMARY

A. Section Includes:

1. The Security Systems Contractor shall include in the bid all labor, materials, tools, plant, transportation, storage costs, software/licenses, installation, programming, configuration, testing, commissioning, training, equipment, insurance, temporary protection, permits,



fire stopping, inspections, taxes and all necessary and related items required to provide complete and operational equipment / systems shown and described in this section.

2. This section is intended to define and describe minimum security system performance, required vendors and equipment, and installation standards and criteria.
3. All equipment and materials provided shall be new and unused and of the most current model or revision. All components of this system shall be installed in a workmanlike manner, following security industry "best practices" and in strict adherence to the manufacturer's specifications and applicable codes.
4. All Security System design guides, schematic designs, design development documents, device location maps, system records, record documents, operating instructions, and emergency response procedures are extremely confidential. Access to these documents shall be restricted to authorized personnel, the Security System Contractor(s), and approved vendors providing associated services. Parties receiving these documents shall take every reasonable precaution to protect these documents from unauthorized access.
5. Failure to follow manufacturer guidelines or the substitution of non-approved equipment or materials shall result in the rejection of the installation and shall require remediation efforts.
6. The Security Contractor shall furnish and install all equipment, accessories and materials in accordance with these specifications and drawings to provide a complete and operating security access and surveillance system.
7. Any material and/or equipment necessary for the proper operation of the surveillance system not specified or described herein shall be deemed part of this specification.
8. Final approval and acceptance of the installed systems rests solely with the Owner's Facility and Security personnel.

### 1.3 DESCRIPTION OF WORK

- A. Provide all labor, materials, equipment, services and accessories necessary to furnish and install the work of this Section, complete and functional, as indicated in the contract documents and as specified herein.
- B. The following standards, requirements, and equipment access control and video management systems shall be provided:
  1. Networked nodes and panels, configured with the appropriate access, alarm input, and temperature probe application blades.
  2. Lock power supplies, 24VDC, with fused protected outputs.
  3. Systems controller with partitioning feature.
  4. Integration with the building's fire alarm system to release fail-safe locks upon activation of the fire detection system.
  5. Doors identified on the drawings as an access control portal shall include at least one card reader, electric door hardware (furnished and installed by others), and door status switch as described elsewhere in this document. Additional components, including external request-to-exit devices and push-to-exit emergency buttons, may also be required for specific applications.
  6. The networked access control panels and power supplies shall be wall mounted in the designated MDF and IDF Room locations shown on the drawings. Each networked access control panel and power supplies will require the following:
    - a. Minimum of one dedicated 120V, 20A power circuit hard-wired into the panel.
    - b. (1) Ethernet connection for each Network Node.
    - c. Fire alarm relay panel for lock power control

7. Security Contractor shall provide and install individual patch cables between the Data Outlet and the Network Node. Coordinate with Telecommunications contractor. Data outlet shall be installed inside Network Node panel enclosure.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Submittals shall include information that confirms compliance with contract requirements. Include the manufacturer's name, model numbers, technical data sheets, and shop drawings as required.
- C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Owner and Engineer to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
- D. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  1. Wiring Diagrams
  2. System labeling schedules.
  3. Cable administration drawings.
  4. Battery and charger calculations for central station, workstations, and controllers.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section "Operation and Maintenance Data," include the following:
  1. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files of the hard-copy submittal.
  2. System installation and setup guides with data forms to plan and record options and setup decisions. Submit manufacturer's operation and maintenance data, customized to the specified systems installed. Include system and operator manuals. Training of staff on hardware and software functions.
  3. Maintenance Service Agreement: Submit a sample copy of the manufacturer's maintenance service agreement, including cost and services for a one-year period for Owner's review.
- B. Record Drawings: During construction maintain record drawings indicating location of equipment and wiring. Submit an electronic version of record drawings for the specified systems no later than Substantial Completion of the project. Project record drawings shall accurately show the physical placement of the following:
  1. Equipment and devices.
  2. Interfaces to fire alarm system and other external systems.

## 1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70, National Electrical Code; SIA CP-01, and SIA CP-07.
- C. The Contractor shall be responsible for providing, installing, and configuring the access control and video surveillance systems as shown. The Contractor shall also provide certification as required.
- D. The access control and video surveillance systems will be installed and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems.
- E. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.
- F. Product Qualifications:
  - 1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
  - 2. The Owner reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.
- G. Contractor Qualifications:
  - 1. The Security Contractor shall be a licensed Security Contractor with a minimum of five (5) years' experience installing and servicing systems of similar scope and complexity.
  - 2. The Contractor shall be an authorized regional representative of the system approved for installation. The Contractor shall provide four (4) current references from clients with systems of similar scope and complexity which became operational in the past three (3) years. At least three (3) of the references shall be utilizing the same system components, in a similar configuration as the proposed system. The references must include a current point of contact, company or agency name, address, telephone number, complete system description, date of completion, and approximate cost of the project.
  - 3. The owner reserves the option to visit the reference sites, with the site owner's permission and representative, to verify the quality of installation and the references' level of satisfaction with the system.
  - 4. The Contractor shall provide copies of system manufacturer certification for all technicians. The Contractor shall only utilize factory-trained technicians to install, program, and service the specified systems. The Contractor shall only utilize factory-trained technicians to install, terminate and service controller/field panels and reader modules.
  - 5. The technicians shall have a minimum of five (5) continuous years of technical experience in electronic security systems. The Contractor shall have a local service facility.
  - 6. The facility shall be located within 60 miles of the project site. The local facility shall include sufficient spare parts inventory to support the service requirements associated with this contract. The facility shall also include appropriate diagnostic equipment to perform diagnostic procedures.

- H. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within four hours of receipt of notification that service is needed.
- I. Pre-installation Conference: Conduct conference at project site.

#### 1.8 PROJECT CONDITIONS

- A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
  - 1. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122-degree F dry bulb and 20 to 90 percent relative humidity, non-condensing.
  - 2. Indoor, Uncontrolled Environment: NEMA 250, enclosures. System components installed in non-temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 0 to 122-degree F dry bulb and 20 to 90 percent relative humidity, non-condensing.

#### 1.9 LINE ITEM PRICING

- A. Provide unit price and extended price for each line of material.
- B. Provide a separate line item for labor, permit fees, taxes and subcontractor mark-up.

#### 1.10 WARRANTY

- A. Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- B. Warranty Period: One year from date of final walk-through and sign-off by the Owner.

### PART 2 - PRODUCTS

#### 2.1 DESCRIPTION:

- A. Security Access System: Subject to compliance with requirements, provide product indicated on Drawings. The access control system for this location shall be Accutech.

#### 2.2 ACCESS CONTROL EQUIPMENT

- A. Network Nodes, Door interface Panels and Input/Output Panels
  - 1. Accutech Access Control
- B. All power supplies shall be – Altronix AL600 with PD16 for panels and devices (12VDC) or ACM8 for locks (24VDC)
- C. Card Readers:
  - 1. All readers shall be Bluetooth enabled.
  - 2. Provide mullion readers for mullion installations.
  - 3. All readers shall communication with access control panels via OSDP.

4. HID ProxPro no Substitution

## 2.3 PUSH-BUTTON SWITCHES

### A. Push-Button Switches:

1. Momentary-contact mushroom-type push buttons with stainless-steel switch enclosures.
2. Single gang, with "PUSH TO EXIT" knob, Green in color.
3. Push-button switches shall be powered from their associated controller, using DC power.
4. Push-button switches shall be equipped with an adjustable 1 to 45 second pneumatic time delay.

### B. Mounts

1. Flush or surface mounting.
2. Push buttons shall be suitable for flush mounting in the switch enclosures.
3. Enclosures shall additionally be suitable for installation in a controlled and uncontrolled indoor environment.

### C. Manufacturer: Dortronics 5236 Series no Substitution

## 2.4 DOOR HARDWARE INTERFACES

### A. Electrified Door Hardware:

1. The Door Hardware Contractor shall be responsible for furnishing and installation of electrified door hardware. Refer to the architectural door and door hardware schedule for additional information and coordination
2. Locksets and exit devices shall have built-in request-to-exit switches.
3. The Security Contractor shall be responsible for connecting the electrified door hardware to the access control system.
4. Power for the electrified door hardware and electromagnetic locks shall be provided by a 24VDC power supply that is furnished and installed by the Security Contractor.
5. All electric hardware installations shall comply with the appropriate requirements of national, State, and local building codes and ordinances, and with requirements for access-controlled doors in a means of egress.

### B. Where required by code or local ordinance, electric door hardware shall be interfaced with local fire alarm and fire protection systems and provided with dedicated push-to-exit emergency release devices.

### C. Door Contacts:

1. Door contacts shall be capable of detecting a 1" separating movement between magnet and switch housing. Upon detection, the door contact shall transmit an alarm signal to the security management system.
2. Door monitored switches shall be SPST recessed type unless otherwise specified.
3. Manufacturer: Interlogix 1078 concealed; 2505A Surface and 2207A-H Overhead Door
4. The color of the switch shall match the color of the door frame as closely as possible.
5. Surface mounted door monitored switches shall have an anodized alloy housing with stainless steel armored cable. Surface mounted switches shall be

### D. External Passive Infrared (PIR) Request-to-Exit Devices:

1. Designed for use with surface-mounted magnetic locks.
2. Wall or ceiling mount, with adjustable field pattern. Exact location will depend on existing conditions and required coverage area. Unless noted otherwise on drawings, conceal wireways and junction box.
3. RTE sensor shall be installed to provide positive detection of a person approaching the door to exit. The sensor should be installed to minimize unwanted detection in halls, corridors, rooms, etc.
4. Manufacturer: Bosch DS-150i series. Light gray or black color to match adjacent finishes.

E. Panic Devices

1. Designed to support alarm message requirements to the Security Desk via push-button.
2. Connected to Access Control System.
3. Manufacturer: Under-Desk-Mounted: HUB2SA by United Security Products.

2.5 FIRE ALARM INTERFACE:

- A. The Fire Alarm Contractor shall provide two (2) fire alarm relays in MDF and each IDF Room. The relay shall be mounted near the access control system power supply and Network Node enclosures.
- B. The Security Contactor shall provide an interconnection between the fire alarm relay and each door power supply. The purpose of the interconnection is drop power to all fail-safe locks upon activation of the fire detection system.
- C. The Security Contractor shall provide an interconnection between the fire alarm relay and each Network Node. The purpose of the interconnection is to provide an alarm input to the Network Node for mustering purposes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
- B. Examine roughing-in for conduits and pathways for access control cabling and conduit at PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with recommendations in SIA CP-01 and CP-07.
- B. Comply with ANSI/TIA 606-C, "Administration Standard for Commercial Telecommunications Infrastructure."
- C. Obtain detailed project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval.

1. Record setup data for control station and workstations.
  2. For each Location, record setup of controller features and access requirements.
  3. Propose start and stop times for time zones and holidays and match up access levels for doors.
  4. Set up groups, facility codes, linking, and list inputs and outputs for each controller.
  5. Assign action message names and compose messages.
  6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
  7. Prepare and install alarm graphic maps.
  8. Develop user-defined fields.
  9. Develop screen layout formats.
  10. Propose setups for guard tours and key control.
  11. Discuss badge layout options; design badges.
  12. Complete system diagnostics and operation verification.
  13. Prepare a specific plan for system testing, startup, and demonstration.
  14. Develop acceptance test concept and, on approval, develop specifics of the test.
- D. In meetings with Architect and Owner, present project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

### 3.3 INSTALLATION REQUIREMENTS

- A. Security Systems Contractor shall execute their work in a neat and skillful manner.
- B. The Security Systems Contractor shall provide all wiring, connectors, power supplies, interfaces, and other hardware as necessary to affect an operating system unless specified as being provided by others in the contract drawings and documents.
- C. Wiring and cabling shall be in conduit where exposed to physical damage or tampering. Method and routing of any exposed raceways and/or wiring shall be approved by the owner prior to installation.
1. Cable that is concealed within building structure or above suspended ceilings shall not require conduit.
  2. Cable that is not accessible due to location or which is installed at or below the roof deck must be attached to the building structure or structural steel using approved hangers, straps, or other suitable methods. Cables shall not rest directly upon structural steel members or suspended ceiling assemblies.
- D. System components and control devices shall be wired to the appropriate power supply, Network Node, and PoE switch as homeruns. Terminations shall be made in a manner consistent with the equipment manufacturer's written installation instructions.
- E. Conductors and cables shall be specified and sized to reduce voltage drop and ensure proper system operation.
1. Data communications wiring between the Network Node and the access control door shall be 4-element composite security cable with an overall jacket.
- F. All cable shall be labeled at origin and termination, referencing to a master legend schedule shown on submittal drawings. Labeling and any splice locations shall be noted on Record Drawings.

- G. Security contractor shall provide trim plates, adapters or back boxes for card readers as needed to mount to electrical back boxes. The color and finish of all trim plates, adapters or back boxes used shall closely match that of the card reader.
- H. Completely seal all exterior openings of outdoor mounted devices and back boxes to make weather-tight.
- I. Request-to-Exit (RTE) sensor housings shall compliment wall and door frame on which the RTE sensor is being installed. Provide trim place to enable mounting of RTE sensor to a single-gang junction box (mounted horizontally).
  - 1. Trim plate shall completely cover rough-in opening.
  - 2. Trim plate color and finish shall match RTE sensor.
- J. Miscellaneous hardware required for installation shall be suitable for the purpose for which it is used. Hardware includes nuts, bolts, screws, washers, miscellaneous fasteners, terminals, terminal strips, tie wraps, and related parts. Where the equipment manufacturer specifies hardware for use in the installation, the hardware specified shall be used. The finish on all hardware and fasteners shall be suitable for the environment in which it will be used and shall be selected to minimize corrosion or deterioration due to moisture, sunlight, or temperature extremes.
- K. All electrical power work and conduit work shall be by licensed electricians.
- L. The Security Systems Contractor will be required to install and test local equipment, programming it with an IP address specified by the Owner. In all circumstances, the Security Systems Contractor's work shall not be considered complete until the equipment has been programmed and tested to the satisfaction of the Owner.

### 3.4 CABLING

- A. Comply with NECA 1, "Good Workmanship in Electrical Construction."
- B. Furnish and install cables and wiring in accordance with these specifications and the requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security."
- C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.
- D. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use UL-listed plenum-rated cable in environmental airspaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
- E. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible.
- F. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.
- G. Furnish and install end-of-line resistors at the field device location, not at the controller or panel location.



### 3.5 CABLE INSTALLATION

- A. Comply with ANSI/TIA-569-E, "Commercial Building Standard for Telecommunications Pathways and Spaces."
- B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.
- C. TIA 232-F Cabling: Cabling between devices shall not exceed 50 feet, or distance allowed by equipment manufacturer.
- D. Card Readers, Keypads, Door Contacts, and Request-to-Exit Devices:
  - 1. Install number of conductor pairs recommended by manufacturer for the functions specified.
  - 2. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.
- E. Install minimum No. 18 AWG cable from controller to electrically powered locks. Do not exceed 500 ft.
- F. Install minimum No. 18 AWG AC power wire from transformer to controller, with a maximum distance of 25 ft.

### 3.6 GROUNDING

- A. Comply with Division 26 "Grounding and Bonding for Electronic Safety and Security."
- B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."
- C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- D. Bond shields and drain conductors to ground at only one point in each circuit.
- E. Signal Ground:
  - 1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
  - 2. Bus: Mount on wall of main equipment room with standoff insulators.
  - 3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

### 3.7 INSTALLATION

- A. Furnish and install card readers, keypads, magnetic locks, push buttons, door contacts, and request-to-exit devices. Provide connectivity to these devices if these devices have been furnished as part of the door hardware.

### 3.8 IDENTIFICATION

- A. In addition to requirements in this article, comply with applicable requirements in Section 260553 "Identification for Electrical Systems" and with ANSI/TIA-606C.

- B. Develop and provide as-built device and cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.
- C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
  - 1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
  - 2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.
- D. At completion, as-built drawings and information provided by the contractor shall reflect as-built conditions.

### 3.9 SYSTEM SOFTWARE AND HARDWARE

- A. Configure and test software and hardware and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

### 3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
  - 2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
  - 3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.
- B. Devices and circuits will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.11 STARTUP SERVICE

- A. Engage a factory-authorized service representative to supervise and assist with startup service.
  - 1. Complete installation and startup checklists according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
  - 2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.
- B. Train Owner's maintenance personnel on equipment operation, startup and shutdown, troubleshooting, servicing and preventative maintenance procedures. Review the data

contained in the Operating and Maintenance Manuals with Owner's personnel. Training shall occur separate from startup activities. Provide 4 hours of training minimum.

### 3.12 PROTECTION

- A. Maintain strict security during the installation of equipment and software. Rooms housing the control stations and workstations that have been powered up shall be locked and secured with an activated security system reporting to a central station complying with UL 1610, "Central-Station Burglar-Alarm Units", during periods when a qualified operator in the employ of Contractor is not present.

### 3.13 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain security access system.
- B. Develop separate training modules for the following:
  - 1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
  - 2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
  - 3. Security personnel.
  - 4. Hardware maintenance personnel.
  - 5. Corporate management.

### 3.14 FINAL ACCEPTANCE

- A. After work is completed, and prior to requesting the Final Acceptance Test, Security Contractor shall conduct a final inspection and pre-test all equipment and system features. Contractor shall correct any deficiencies discovered as the result of the inspection and pre-test.
- B. Contractor shall notify Owner and Engineer to schedule a Final Acceptance Test. The request for Acceptance Test shall constitute a certification from the Security Contractor that all work is complete and in compliance with the Contractor Documents, all systems have been tested, and all corrections have been made.
- C. Technicians performing the acceptance test shall have been involved in the installation of the system and shall be thoroughly familiar with all aspects of the work.
- D. Security Contractor shall provide all ladders, tools, test equipment as needed to accomplish the Final Acceptance Test.
- E. Any portions of the work found to be deficient or not in compliance with the Contract Documents will be rejected.

END OF SECTION 281300

## PART 1 - GENERAL

### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.
- B. Related Sections:
1. Division 07 – Through-penetration Firestop Systems
  2. Division 26 – Common Work Results for Electrical
  3. Division 26 – Low Voltage Electrical Power Conductors and Cables
  4. Division 26 – Grounding and Bonding for Electrical Systems
  5. Division 26 – Hangers and Supports for Electrical Systems
  6. Division 26 – Raceways and Boxes for Electrical Systems
  7. Division 26 – Identification for Electrical Systems
  8. Division 27 – General Requirements for Telecommunications
  9. Division 27 – Common Work Elements for Communications Systems
  10. Division 27 – Network Communications Systems
  11. Division 27 – Two-Way Communications System
  12. Division 27 – Audiovisual Systems
  13. Division 27 – Nurse Call/Code Blue
  14. Division 28 – Common Work Elements for Electronic Safety and Security
  15. Division 28 – Physical Electronic Safety and Security
  16. Division 28 – Video Surveillance System
- C. Reference Symbols:
1. All device symbols are defined by the appropriate symbol schedules. Because of the scale of the drawings, symbols are shown on drawings as close as possible to the mounting location.
    - a. Contractor shall coordinate exact locations with all architectural drawings, site plans, reflected ceiling plans, furniture plans, mechanical and electrical drawings as well as all affected trades prior to submittal of any shop drawings.
- D. Abbreviations:
1. Refer to Specification Section 28 05 00 for additional information.
- E. Definitions:
1. Refer to Specification Section 28 05 00 for additional information.

### 1.2 SUMMARY

- A. The intent of this specification is to establish a standard of quality, overall system configuration and equipment requirements for the installation of a new TCP/IP-based Video Surveillance System (CCTV). The contractor shall be responsible for providing all design, installation, programming, commissioning, testing and certifications as necessary to provide a complete, fully integrated and operating TCP/IP-based Video Surveillance System in accordance with the Contract Drawings and/or as herein specified.

- B. The installation, performance, features, functions, software and programming criteria as specified herein as well as all related specification sections have been designed to offer the maximum system efficiency ease of operation, occupant safety and the protection of equipment as recommended.
  - 1. The scope of work for this project shall include but not limited to providing all necessary conduits, cabling, equipment, components, devices, network video recorders, materials, active network electronics, integration of existing surveillance cameras and ancillary systems in order to provide a seamless and fully integrated video management system.
  - 2. In addition, the video management system platform shall also be fully integrated in a seamless manner with the Stations' new Physical Access Control System (PACS) providing a secondary platform with full operational control and monitoring of all video surveillance system cameras, network recorders and all system functions accessible from the PACS client workstations.
  - 3. The integration to the PACS shall permit system operators to monitor/control and trigger specific surveillance cameras, video monitors and video recordings as well as all related events and alarms annunciated by the physical access control, intrusion detection and emergency call systems.
  - 4. The PACS workstation shall provide a graphical display of all events, controls and functions for all video surveillance system functions and features. Surveillance systems which Do Not conform to the performance criteria or Do Not provide for all functional and operational capabilities in a seamless manner through the PACS platform shall not be acceptable. Refer to all related specification sections for additional information.

### 1.3 REFERENCES

- A. The publications listed below (including amendments, addenda, revisions, supplement, and errata) shall form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
  - 1. Closed Circuit Television Manufacturers Association (CCTMA).
  - 2. Open Network Video Interface Forum (ONVIF)
- B. All references to industry and trade association standards as well as all building codes are minimum installation requirements for this system. The codes, standards and agencies listed in specification section 28 05 00 shall form a part of this specification section and all work shall comply with the latest adopted standards.
  - 1. The publications listed in specification section 28 05 00 (including all amendments, addenda, revisions, supplement, and errata) shall form a part of this specification section to the extent referenced. The publications are referenced in the aforementioned specification section by the basic designation only.
  - 2. Where the contract drawings and/or specification sections mandate a greater requirement or performance than those specified by the aforementioned referenced codes and standards in section 28 05 00, shall then be the governing requirements for this project. Refer to specification section 28 05 00 for all minimum codes and standards to be applied for this project.

### 1.4 SUBMITTALS

- A. In addition to all requirements as specified by Specification Section 28 05 00 the video surveillance system shall also be provided in accordance with the following requirements:
  - 1. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
  - 2. Shop Drawings: For video surveillance. Include plans, elevations, sections, details, and attachments to other work.
  - 3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 4. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
  - 5. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
  - 6. UPS: Sizing calculations.
  - 7. Wiring Diagrams: For power, signal, and control wiring.
  
- B. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation.

## 1.2 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data

## 1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NECA 1.
- C. Comply with NFPA 70.
- D. Electronic data exchange between the video surveillance system and access-control system shall comply with SIA TVAC.

## 1.4 LINE-ITEM PRICING

- A. Provide unit price and extended price for each line of material.
- B. Include additional line items for the following:
  - 1. Field installation labor – note if providing union or non-union labor
  - 2. Project management/shop labor
  - 3. Permit fees
  - 4. Taxes
  - 5. First year warrantee and service contract
  - 6. Any subcontractor mark-ups
- C. Provide separate pricing to identify any monthly or yearly re-occurring licensing costs required for operation and identify if these costs are included as part of the all-in first year cost in the proposal.
- D. Provide separate pricing to identify year 2 and year 3 warrantee and recommended preventative maintenance costs.

- E. Provide separate pricing for alternates as indicated in Part 2 below.

## 1.5 WARRANTY

- A. Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- B. Warranty Period: One year from date of final walk-through and sign-off by the Owner for all parts and labor.

## PART 2 - PRODUCTS

### 2.1 SYSTEM REQUIREMENTS

#### A. Description:

1. On-premise operating system with sufficient licensing levels and software updates for secure and reliable system operation for a minimum of one year for all devices installed under this scope of work.
2. The Video Surveillance system for this project shall be Qognify Ocularis VMS. onsite storage per requirements below.
3. Provide PoE Switches for all IP Based cameras.
4. Camera system units shall be ruggedly built and designed for extreme adverse environments, complying with NEMA Type environmental standards.
5. All system interconnect cables, workstation PCs, PTZ joysticks, and network intermediate devices shall be provided for full performance of specified system.
6. Surge Protection:
  - a. Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.
  - b. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements as recommended by manufacturer for type of line being protected.
7. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display shall identify tamper alarms and indicate locations.

### 2.2 NETWORK VIDEO RECORDERS

#### A. Manufacturer –Qognify as required to meet capture retention requirements.

1. NVR storage additional capacity shall be calculated based on following parameters:
  - a. Minimum video retention rate – 60 days
  - b. Minimum camera frame rate – 15 frames per second for interior cameras and 30 frames per second for exterior cameras
  - c. Minimum camera resolution – Maximum resolution of each specified camera.
  - d. Motion-based recording for all cameras with mandatory (5) seconds pre-alarm recording. Continuous recording for all exterior Cameras
  - e. Spare storage capacity – 20%.

## 2.3 IP CAMERA SYSTEMS

- A. Color Dome Camera: Assembled and tested as a manufactured unit, containing fixed color camera, varifocal lens, and vandal resistant dome assembly.
- B. Provide all wall and ceiling mounting hardware and brackets as indicated on drawing details. Coordinate color of mounting hardware with owner and architect before installation.
- C. PTZ Camera: Assembled and tested as a manufactured unit, containing color camera, varifocal lens, vandal resistant dome assembly, Pan Tilt, Zoom capability and controls
- D. Approved list of Camera Manufacturers:
  - 1. Acti – basis of design, with models for each camera indicated on drawings.
  - 2. Axis – Approved equal.

## 2.4 POWER SUPPLIES

- A. Low-voltage power supplies matched for voltage and current requirements of cameras and accessories, and of type as recommended by manufacturer of camera.
- B. Annunciation: Indicate change in system condition and switching of system or component to backup power.

## PART 3 - EXECUTION

### 3.1 VIDEO SURVEILLANCE SYSTEM INSTALLATION

- A. Install cameras so that each is level and plumb.
- B. Install cameras with 84-inch-minimum clear space below cameras and their mountings. Maximum outdoor camera height shall not exceed 13ft above ground. Change type of mounting to achieve required clearance. Keep camera views free from all obstructions.
- C. Install power supplies and other auxiliary components at control stations unless otherwise indicated.
- D. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system-component enclosures and mounted in self-protected, inconspicuous positions.
- E. Identify system components, wiring, cabling, and terminals according to Section "Identification for Electrical Systems."
- F. Miscellaneous hardware required for installation shall be suitable for the purpose for which it is used. Hardware includes nuts, bolts, screws, washers, miscellaneous fasteners, terminals, terminal strips, tie wraps, and related parts. Where the equipment manufacturer specifies hardware for use in the installation, the hardware specified shall be used. The finish on all hardware and fasteners shall be suitable for the environment in which it will be used and shall be selected to minimize corrosion or deterioration due to moisture, sunlight, or temperature extremes.
- G. All electrical power work and conduit work shall be by licensed electricians.



- H. The Security Systems Contractor will be required to install and test local equipment, programming it with an IP address specified by the Owner. This support shall include the coordination of dates and times for programming and the testing of individual devices following programming. In all circumstances, the Security Systems Contractor's work shall not be considered complete until the equipment has been programmed and tested to the satisfaction of the Owner.

### 3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
  - 1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
  - 2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:
    - a. Prepare equipment list described in "Informational Submittals" Article.
    - b. Verify operation of auto-iris lenses.
    - c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
    - d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
    - e. Set and name all preset positions; consult Owner's personnel.
    - f. Set sensitivity of motion detection.
    - g. Connect and verify responses to alarms.
    - h. Verify operation of control-station equipment.
  - 3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
  - 4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.
- C. Video surveillance system will be considered defective if it does not pass tests and inspections.
- D. Prepare and issue test and inspection reports.
- E. After work is completed, and prior to requesting the Final Acceptance Test, the Security Contractor shall conduct a final inspection and pre-test all equipment and system features. The Security Contractor shall correct any deficiencies discovered as the result of the inspection and pre-test.

- F. The Security Contractor shall notify Owner and Engineer to request a Final Acceptance Test. The request for Acceptance Test shall constitute a certification from the Security Contractor that:
  - 1. All work is complete and in compliance with the Contract Documents.
  - 2. All systems have been tested.
  - 3. All corrections have been made.
- G. Technicians performing the acceptance test shall have been involved in the installation of the system and shall be thoroughly familiar with all aspects of the work.
- H. The Security Contractor shall provide all ladders, tools, test equipment as needed to accomplish the Final Acceptance Test.
- I. Any portions of the work found to be deficient or not in compliance with the Contract Documents will be rejected.

### 3.3 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

### 3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's Security personnel to adjust, operate, and maintain video-surveillance equipment.
- B. Train Owner's maintenance personnel on equipment operation, startup and shutdown, troubleshooting, servicing, and preventative maintenance procedures. Review the data contained in the Operating and Maintenance Manuals with Owner's personnel. Training shall occur separate from startup activities. Provide 8 hours of training minimum.

END OF SECTION

RESIDENT WANDER GUARD SYSTEM

PART 1 - GENERAL

1.1 STIPULATIONS

A. Project drawings and general provisions of the Contract, including but not limited to all; General and Supplementary Conditions, Division 01 Specification Sections and all stipulated Specification Sections shall apply to this and all related Division 27 specification sections.

B. Related Sections:

1. Division 07 – Through-penetration Firestop Systems
2. Division 08 – Door Hardware
3. Division 26 – Common Work Results for Electrical
4. Division 26 – Low Voltage Electrical Power Conductors and Cables
5. Division 26 – Grounding and Bonding for Electrical Systems
6. Division 26 – Hangers and Supports for Electrical Systems
7. Division 26 – Raceways and Boxes for Electrical Systems
8. Division 26 – Identification for Electrical Systems
9. Division 27 – Common Work Elements for Communications Systems
10. Division 27 – Network Communications Systems
11. Division 28 – Common Work Elements for Electronic Safety and Security
12. Division 28 – Physical Electronic Safety and Security

C. Reference Symbols:

1. All device symbols are defined by the appropriate symbol schedules. Because of the scale of the drawings, symbols are shown on drawings as close as possible to the mounting location.
2. Contractor shall coordinate exact locations with all architectural drawings, site plans, reflected ceiling plans, furniture plans, mechanical and electrical drawings as well as all affected trades prior to submittal of any shop drawings.

D. Abbreviations:

1. Refer to Specification Section 28 05 00 for additional information.

E. Definitions:

1. Refer to Specification Section 28 05 00 for additional information.

1.2 SUMMARY

A. Section Includes:

1. The Contractor shall include in the bid all labor, materials, tools, plant, transportation, storage costs, software/licenses, installation, programming, configuration, testing, commissioning, training, equipment, insurance, temporary protection, permits, fire stopping, inspections, taxes and all necessary and related items required to provide complete and operational equipment / systems shown and described in this section.

2. This section is intended to define and describe minimum system performance, required vendors and equipment, and installation standards and criteria.
3. All equipment and materials provided shall be new and unused and of the most current model or revision. All components of this system shall be installed in a workmanlike manner, following security industry "best practices" and in strict adherence to the manufacturer's specifications and applicable codes.
4. All Resident Wanderer System design guides, schematic designs, design development documents, device location maps, system records, record documents, operating instructions, and emergency response procedures are extremely confidential. Access to these documents shall be restricted to authorized personnel, the System Contractor(s), and approved vendors providing associated services. Parties receiving these documents shall take every reasonable precaution to protect these documents from unauthorized access.
5. Failure to follow manufacturer guidelines or the substitution of non-approved equipment or materials shall result in the rejection of the installation and shall require remediation efforts.
6. The Contractor shall furnish and install all equipment, accessories, and materials in accordance with these specifications and drawings to provide a complete and operating resident wanderer system.
7. Any material and/or equipment necessary for the proper operation of the wanderer system not specified or described herein shall be deemed part of this specification.
8. Final approval and acceptance of the installed systems rests solely with the Owner's Facility and Security personnel.

### 1.3 DESCRIPTION OF WORK

- A. Provide all labor, materials, equipment, services and accessories necessary to furnish and install the work of this Section, complete and functional, as indicated in the contract documents and as specified herein.
- B. The following standards, requirements, and equipment for resident wanderer system shall be provided:
  1. Networked nodes and panels, configured with the appropriate access, and alarm input
  2. Systems controller with partitioning feature.
  3. Integration with the building's access control system.
  4. Doors identified on the drawings as a portal shall include an arming keypad, at least one card reader, electric door hardware (furnished and installed by others), and door status switch. Additional components, including external request-to-exit devices and push-to-exit emergency buttons, may also be required for specific applications.
  5. Contractor shall provide and install individual patch cables between the Data Outlet and the Network Node. Coordinate with Telecommunications contractor. Data outlet shall be installed inside Network Node panel enclosure.
  6. Premise or cloud-based operating system with sufficient licensing levels and software updates for secure and reliable system operation for a minimum of one year for all devices installed under this scope of work.

### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.

- B. Submittals shall include information that confirms compliance with contract requirements. Include the manufacturer's name, model numbers, technical data sheets, and shop drawings as required.
- C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Owner and Engineer to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
- D. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Wiring Diagrams
  - 2. System labeling schedules.
  - 3. Cable administration drawings.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wander guard system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section "Operation and Maintenance Data," include the following:
  - 1. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files of the hard-copy submittal.
  - 2. System installation and setup guides with data forms to plan and record options and setup decisions. Submit manufacturer's operation and maintenance data, customized to the specified systems installed. Include system and operator manuals. Training of staff on hardware and software functions.
  - 3. Maintenance Service Agreement: Submit a sample copy of the manufacturer's maintenance service agreement, including cost and services for a one-year period for Owner's review.
- B. Record Drawings: During construction maintain record drawings indicating location of equipment and wiring. Submit an electronic version of record drawings for the specified systems no later than Substantial Completion of the project. Project record drawings shall accurately show the physical placement of the following:
  - 1. Equipment and devices.
  - 2. Interfaces to fire alarm system and other external systems.

#### 1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70, National Electrical Code; SIA CP-01, and SIA CP-07.
- C. The Contractor shall be responsible for providing, installing, and configuring the access control and video surveillance systems as shown. The Contractor shall also provide certification as required.

- D. The resident wanderer system will be installed and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems.
- E. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.
- F. Product Qualifications:
  - 1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
  - 2. The Owner reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.
- G. Contractor Qualifications:
  - 1. The Contractor shall be a licensed Contractor with a minimum of five (5) years' experience installing and servicing systems of similar scope and complexity.
  - 2. The Contractor shall be an authorized regional representative of the system approved for installation. The Contractor shall provide four (4) current references from clients with systems of similar scope and complexity which became operational in the past three (3) years. At least three (3) of the references shall be utilizing the same system components, in a similar configuration as the proposed system. The references must include a current point of contact, company or agency name, address, telephone number, complete system description, date of completion, and approximate cost of the project.
  - 3. The owner reserves the option to visit the reference sites, with the site owner's permission and representative, to verify the quality of installation and the references' level of satisfaction with the system.
  - 4. The Contractor shall provide copies of system manufacturer certification for all technicians. The Contractor shall only utilize factory-trained technicians to install, program, and service the specified systems. The Contractor shall only utilize factory-trained technicians to install, terminate and service controller/field panels and reader modules.
  - 5. The technicians shall have a minimum of five (5) continuous years of technical experience in electronic security systems. The Contractor shall have a local service facility.
  - 6. The facility shall be located within 60 miles of the project site. The local facility shall include sufficient spare parts inventory to support the service requirements associated with this contract. The facility shall also include appropriate diagnostic equipment to perform diagnostic procedures.
- H. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within four hours of receipt of notification that service is needed.
- I. Pre-installation Conference: Conduct conference at project site.

## 1.8 PROJECT CONDITIONS

- A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
  - 1. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in temperature-controlled indoor

environments shall be rated for continuous operation in ambient conditions of 36 to 122-degree F dry bulb and 20 to 90 percent relative humidity, non-condensing.

2. Indoor, Uncontrolled Environment: NEMA 250, enclosures. System components installed in non-temperature-controlled indoor environments shall be rated for continuous operation in ambient conditions of 0 to 122-degree F dry bulb and 20 to 90 percent relative humidity, non-condensing.

#### 1.9 LINE-ITEM PRICING

- A. Provide unit price and extended price for each line of material.
- B. Include additional line items for the following:
  1. Field installation labor – note if providing union or non-union labor
  2. Project management/shop labor
  3. Permit fees
  4. Taxes
  5. First year warrantee and service contract
  6. Any subcontractor mark-ups
- C. Provide separate pricing to identify any monthly or yearly re-occurring licensing costs required for operation and identify if these costs are included as part of the all-in first year cost in the proposal.
- D. Provide separate pricing to identify year 2 and year 3 warrantee and recommended preventative maintenance costs.
- E. Provide separate pricing for alternates as indicated in Part 2 below.

#### 1.10 WARRANTY

- A. Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- B. Warranty Period: One year from date of final walk-through and sign-off by the Owner for all parts and labor.

### PART 2 - PRODUCTS

#### 2.1 DESCRIPTION:

- A. Resident Wander Guard System: Subject to compliance with requirements, provide product indicated on Drawings. The Wander Guard system shall consist of an RF transmitter, an RF Local Area Receiver, and low frequency Exciter, and a Controller PC. When an RFID Tag detects that it is within the range of an Exciter, it shall send a signal, which is picked up by a Local Area Receiver. The Local Area Receiver decodes the signal and forwards the data through a data network to the Controller PC. The Controller PC shall be capable of displaying the RFID Tag's unique serial code and the time the signal was received. The Controller PC shall provide a programmable, audible announcement of each alarm. If the Controller PC determines that an "unsafe" condition is present, a security alarm shall be transmitted. The Exciter shall be capable of activating magnetic door locks and other security monitoring devices. The alarm can only be cancelled by password-authorized staff at the Controller PC. The resident wander guard system for this location shall be Accutech Healthcare Security Solutions Resident Guard Wander Management platform

B. Accutech Healthcare Security Solutions Resident Wander Guard Management Platform

1. The system shall utilize Common-Off-The-Shelf (COTS) computer workstations, servers and networking devices.
2. The system shall be integrated with the card access control and nurse call systems to provide seamless activation of magnetic locks, sounder, and corridor lights upon detection of an RFID tag by the portal exciter.
3. Components of the Wander Guard System must be protected from voltage surge originating externally to equipment housing and entering through power, communication, signal, and control or sensing leads. Tamper switches on enclosures, control units, and other system components shall initiate a tamper alarm signal when the unit is opened or partially disassembled with a unique alarm signal transmitted to the security operation center as a tamper signal.
4. The wander guard system shall be an integrated tracking system comprising of PC server/workstation connected directly to a network of local area receivers, exciters and I/O modules that receives signals from the network local area receivers to provide a centralized monitoring system.
5. When an alarm is received from an exciter, an audible and visual annunciation shall be activated by the wander guard controller at the exciter portal in alarm (door or elevator).
6. The PC workstation connected to the controller shall display and log all system activity including system history, programming parameters including password and user codes.
7. The Wander Guard shall be integrated with:
  - a. The ACS and magnetic locks to lock doors once a RFID tag is detected by a portal exciter.
  - b. The fire alarm system to provide system override of the Wander Guard system locks upon activation of the fire alarm system.
  - c. The elevator interlock system that prevents elevator travel once a RFID tag is detected by a portal exciter

2.2 RFID TAG

- A. Shall be fully supervised, waterproof, programmed to transmit a unique digitally encoded ID number received by the LARs for transmission and display on Client workstation as shown on drawings. The tag shall incorporate a tamper detection mechanism that is enabled as soon as the tag is attached to the individual. When attached, Tag shall emit an encoded signal to auto-admit the RFID tag into the Wander Guard System with no further staff action. Tag shall use a tamper proof, hypoallergenic strap that can be adjusted for individual weight loss. Strap shall contain no latex. The tag shall cause the System to generate an alarm under any of the following conditions:
1. Someone tries to exit through a protected doorway without authorization.
  2. The Tag's signal has not been detected by the system for a programmable, specific time.
  3. The strap has been cut or tampered with.
  4. The tag's battery is low.
  5. An authorized exit has occurred, but someone tries to "piggyback" through the protected exit with another protected individual.
  6. An authorized exit has occurred, but the individual has not returned to the designated safe area within a user-specified time.
  7. The following shall apply to the RFID tags:
    - a. Power Requirements: Lithium battery
    - b. Supervision Type: Fully supervised, programmable time interval.
    - c. Test Procedure: Self-diagnostic, polled by central processor.
    - d. Weight: Approximately 0.35 oz. (10 g).



## 2.3 PORTAL EXCITER

- A. The unit shall project an RF field around the monitored doors as shown on the drawings to detect the RFID Tags that comes within its range. The Portal Exciter shall contain two programmable relay outputs that can operate magnetic locks, activate visual alarms, and sound audible warning devices. The Exciter shall include protection against over-voltage, transient voltage, and power supply reverse wiring. Power and service LEDs shall be provided along with the following capabilities:
1. Operating Range: Approximately 15 feet.
  2. Detection Range: Adjustable up to 8.5 feet (2.6 m).
  3. Functions: (2) programmable, 30 V DC, 1 Amp, SPDT relays.
  4. Supervision: Fully supervised, with regular polling by Controller PC.
  5. Test Procedure: Self-diagnostic, polled by central processor.
  6. Power: 12 to 30 VDC, 200 mA @ 24 V DC, 500 mA maximum.
  7. Operating Temperature: 32° to 120° F (0° to 49° C).
  8. Humidity: 0 to 85% at 70° F (21° C), non-condensing.
  9. Mounting: Hardware to accommodate wall or ceiling mounting.
  10. Relay Outputs: 2 programmable to:
    - a. Activate power to magnetic lock and audible devices
    - b. Provide a signal to the nurse call system to activate staff paging and corridor lights
    - c. Integrate with elevator controls to restrict elevator movement

## 2.4 LOCAL AREA RECEIVER

- A. The LRA shall provide an interface between the wireless RFID tags and the central monitor unit. It shall convert RF signal into a data stream and connect to the central processor in a daisy chain configuration as shown on the drawings.
- B. Power and service LEDs shall be provided along with the following capabilities:
1. Frequency: 217 MHZ
  2. Detection Radius: 50 ft. (15 meters) overlapping
  3. Bandwidth: 16 KHZ
  4. Supervision: Fully supervised, with regular polling by Controller PC.
  5. Test Procedure: Self-diagnostic, polled by central processor.
  6. Power: 12 to 30 VDC, 100 mA maximum, powered from network power supply
  7. Operating Temperature: 32° to 120° F (0° to 49° C).
  8. Humidity: 0 to 85% at 70° F (21° C), non-condensing.
  9. Mounting: Hardware to accommodate wall or ceiling mounting.
  10. Weight: Approximately 9.2 oz (260 g)

## 2.5 CENTRAL POWER SUPPLY

- A. The dual-voltage Central Power Supply shall provide multiple, separate 12 or 24 VDC regulated outputs to supply power to network and peripheral devices, including Local Area Receivers, Exciters, Range Extenders, optional keypads, and I/O Modules. The Central Power Supply enclosure shall accommodate either one 12 V battery (12 V output) or two 12 V batteries (24 V output).
1. Supply Voltage: 115 VAC, 60 Hz, 1.9 A from the emergency generator power circuit and an Uninterruptible Power Supply (UPS) to provide uninterrupted operation from a loss of utility supplied power. The UPS shall be sized to provide a minimum of 15 minutes of stand by power for the Wander Guard System.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
- B. Examine roughing-in for conduits and pathways for access control cabling and conduit at PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Comply with recommendations in SIA CP-01 and CP-07.
- B. Comply with ANSI/TIA 606-C, "Administration Standard for Commercial Telecommunications Infrastructure."
- C. Obtain detailed project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval.
  - 1. Record setup data for control station and workstations.
  - 2. For each Location, record setup of controller features and access requirements.
  - 3. Assign action message names and compose messages.
  - 4. Set up alarms.
  - 5. Prepare and install alarm graphic maps.
  - 6. Develop user-defined fields.
  - 7. Develop screen layout formats.
  - 8. Complete system diagnostics and operation verification.
  - 9. Prepare a specific plan for system testing, startup, and demonstration.
  - 10. Develop acceptance test concept and, on approval, develop specifics of the test.
- D. In meetings with Architect and Owner, present project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

### 3.3 INSTALLATION REQUIREMENTS

- A. Contractor shall execute their work in a neat and skillful manner.
- B. The Contractor shall provide all wiring, connectors, power supplies, interfaces, and other hardware as necessary to affect an operating system unless specified as being provided by others in the contract drawings and documents.
- C. Wiring and cabling shall be in conduit where exposed to physical damage or tampering. Method and routing of any exposed raceways and/or wiring shall be approved by the owner prior to installation.
  - 1. Cable that is concealed within building structure or above suspended ceilings shall not require conduit.

2. Cable that is not accessible due to location or which is installed at or below the roof deck must be attached to the building structure or structural steel using approved hangers, straps, or other suitable methods. Cables shall not rest directly upon structural steel members or suspended ceiling assemblies.
- D. System components and control devices shall be wired to the appropriate power supply, Network Node, and PoE switch as homeruns. Terminations shall be made in a manner consistent with the equipment manufacturer's written installation instructions.
  - E. Conductors and cables shall be specified and sized to reduce voltage drop and ensure proper system operation.
    1. Data communications wiring between the Network Node and the access control door shall be cable with an overall jacket.
  - F. All cable shall be labeled at origin and termination, referencing to a master legend schedule shown on submittal drawings. Labeling and any splice locations shall be noted on Record Drawings.
  - G. Completely seal all exterior openings of outdoor mounted devices and back boxes to make weather tight.
  - H. Miscellaneous hardware required for installation shall be suitable for the purpose for which it is used. Hardware includes nuts, bolts, screws, washers, miscellaneous fasteners, terminals, terminal strips, tie wraps, and related parts. Where the equipment manufacturer specifies hardware for use in the installation, the hardware specified shall be used. The finish on all hardware and fasteners shall be suitable for the environment in which it will be used and shall be selected to minimize corrosion or deterioration due to moisture, sunlight, or temperature extremes.
  - I. All electrical power work and conduit work shall be by licensed electricians.
  - J. The Contractor will be required to install and test local equipment, programming it with an IP address specified by the Owner. In all circumstances, the Contractor's work shall not be considered complete until the equipment has been programmed and tested to the satisfaction of the Owner.

### 3.4 CABLING

- A. Comply with NECA 1, "Good Workmanship in Electrical Construction."
- B. Furnish and install cables and wiring in accordance with these specifications and the requirements in Section 280513 "Conductors and Cables for Electronic Safety and Security."
- C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.
- D. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use UL-listed plenum-rated cable in environmental airspaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
- E. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible.

- F. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.
- G. Furnish and install end-of-line resistors at the field device location, not at the controller or panel location.

### 3.5 CABLE INSTALLATION

- A. Comply with ANSI/TIA-569-E, "Commercial Building Standard for Telecommunications Pathways and Spaces."
- B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.
- C. TIA 232-F Cabling: Cabling between devices shall not exceed 50 feet, or distance allowed by equipment manufacturer.
- D. Keypads, Transmitters, Door Contacts, and Receivers:
  - 1. Install number of conductor pairs recommended by manufacturer for the functions specified.
  - 2. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.
- E. Install minimum No. 18 AWG cable from controller to electrically powered locks. Do not exceed 500 ft.
- F. Install minimum No. 18 AWG AC power wire from transformer to controller, with a maximum distance of 25 ft.

### 3.6 GROUNDING

- A. Comply with Division 26 "Grounding and Bonding for Electronic Safety and Security."
- B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."
- C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- D. Bond shields and drain conductors to ground at only one point in each circuit.
- E. Signal Ground:
  - 1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
  - 2. Bus: Mount on wall of main equipment room with standoff insulators.
  - 3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

### 3.7 IDENTIFICATION

- A. In addition to requirements in this article, comply with applicable requirements in Section 260553 "Identification for Electrical Systems" and with ANSI/TIA-606C.
- B. Develop and provide as-built device and cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.
- C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
  - 1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
  - 2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.
- D. At completion, as-built drawings and information provided by the contractor shall reflect as-built conditions.

### 3.8 SYSTEM SOFTWARE AND HARDWARE

- A. Configure and test software and hardware and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

### 3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
  - 2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
  - 3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.
- B. Devices and circuits will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.10 STARTUP SERVICE

- A. Engage a factory-authorized service representative to supervise and assist with startup service.

1. Complete installation and startup checklists according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
  2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.
- B. Train Owner's maintenance personnel on equipment operation, startup and shutdown, troubleshooting, servicing and preventative maintenance procedures. Review the data contained in the Operating and Maintenance Manuals with Owner's personnel. Training shall occur separate from startup activities. Provide 4 hours of training minimum.

### 3.11 PROTECTION

- A. Maintain strict security during the installation of equipment and software. Rooms housing the control stations and workstations that have been powered up shall be locked and secured , during periods when a qualified operator in the employ of Contractor is not present.

### 3.12 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain security access system.
- B. Develop separate training modules for the following:
1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
  2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
  3. Security personnel.
  4. Hardware maintenance personnel.
  5. Corporate management.

### 3.13 FINAL ACCEPTANCE

- A. After work is completed, and prior to requesting the Final Acceptance Test, the Contractor shall conduct a final inspection and pre-test all equipment and system features. Contractor shall correct any deficiencies discovered as the result of the inspection and pre-test.
- B. Contractor shall notify Owner and Engineer to schedule a Final Acceptance Test. The request for Acceptance Test shall constitute a certification from the Contractor that all work is complete and in compliance with the Contractor Documents, all systems have been tested, and all corrections have been made.
- C. Technicians performing the acceptance test shall have been involved in the installation of the system and shall be thoroughly familiar with all aspects of the work.
- D. Contractor shall provide all ladders, tools, test equipment as needed to accomplish the Final Acceptance Test.
- E. Any portions of the work found to be deficient or not in compliance with the Contract Documents will be rejected.

END OF SECTION 283300

SECTION 311100  
CLEARING AND GRUBBING

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 DESCRIPTION

- A. Clear and remove all objectionable material, including rubbish, junk, trees, stumps, brush, roots, down timber, rotten wood, and any other vegetation from the limits of grading.

PART 2- PRODUCTS

2.1 EQUIPMENT

- A. Contractor shall use equipment that is suited to perform the work.

PART 3- EXECUTION

3.1 CLEARING AND GRUBBING

- A. Excavation work shall not be initiated in any area until the clearing and grubbing operations within that area have been completed, with the exception that stumps may be removed during the excavation operations.
- B. All materials removed by the clearing and grubbing operations belong the property owner. In the event the property owner does not want the materials, they shall be burned, where permitted, in accordance with applicable laws, ordinances, rules and regulations, or otherwise disposed of by the contractor.
- C. Topsoil must be stripped and temporarily stored on site within limit of work lines in accordance with the erosion and sedimentation control plan.

END OF SECTION

SECTION 312313  
SUBGRADE PREPARATION

PART 1- GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 DESCRIPTION

- A. See current Pennsylvania Department of Transportation Form 408 Specifications, Section 210, Subgrade, Subsection 210.1.
- B. Refer to section 312316 for related requirements.

PART 2- PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 CONSTRUCTION

- A. See current Pennsylvania Department of Transportation Form 408 Specifications, Section 210, Subgrade, Subsection 210.3.

END OF SECTION



SECTION 312316  
EXCAVATION/EARTHWORK

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 DESCRIPTION

- A. This work is excavation for roadways, roadway appurtenances, ditches, culverts, drains, site grading, sedimentation/detention basin and all other grading shown on drawings.

1.3 BASIS OF CONTRACT

- A. Excavation for this Project shall be considered unclassified and shall include all types of earth and soil, any pebbles, boulders, and bedrock, municipal trash, rubbish and garbage, and all types of debris of the construction industry such as wood, stone, concrete, plaster, brick, mortar, steel and iron shapes, pipe, wire, asphaltic materials, paper, and glass. Unclassified excavation does not include unforeseen concrete foundations, walls, or slabs. All such materials encountered which are identified by this paragraph as unclassified shall be removed to the required widths and depths to create a finished product as shown and/or noted on the drawings and as written in the specifications. No additional compensation shall be made to the contractor for this unclassified excavation. The materials defined by this paragraph as unclassified will not be considered to be concealed conditions or unknown physical conditions below the surface of the ground for purposes of interpreting the language in the General Conditions to the Construction Contract.

1.4 SUBSURFACE INFORMATION

- A. Any available data concerning subsurface materials or conditions based on soundings, test pits, or test borings, has been obtained by the Department for its own use in designing this Project. The Test Boring location drawings and the Test Boring Logs, as well as the Laboratory Test Results, contained within the Geotechnical Report are incorporated into the construction contract as a Contract Document. The remainder of the Geotechnical Report, with all other exhibits, is available for informational/guidance purposes only; it is not to be relied on by prospective Bidders. The Report is available to Bidders, but the Bidders must agree and acknowledge that the information and recommendations in the Report are not warranted for accuracy, correctness, or completeness, and is not incorporated into the construction contract as a Contract Document.
- B. Test Boring logs reflect the conditions at the specific locations of each Test Boring only. The Contractor accepts full responsibility for any conclusions drawn with respect to conditions between Test Borings. Bidders may perform their own investigation of existing subsurface conditions, with the Department's approval. Excavation for the Project is "Unclassified", as fully described in the Earthwork Section.

1.5 APPROVAL OF BEARING STRATA

- A. The Contractor shall furnish adequate advance notification to the Department and the Professional of times when footing excavations or paving subgrades are to be completed, so that the Construction Stage Geotech Quality Assurance Agent can verify that the bearing quality of the soil has been properly inspected and/or tested by the Contractor. Formwork and concreting shall follow only after approval by the Construction Stage Geotech Quality Assurance Agent.

- B. Should the bearing at the levels indicated be found by the Professional and the Department to be inadequate, they may order the excavation carried down to sound bearing. Such excavation shall be classed as additional work and payment be made on the basis of an agreed price according to the General Conditions. Should suitable bearing be found at a lesser depth than indicated, the Professional and the Department may order the reduction of excavation specified or shown on the drawings, and the Contractor shall allow a credit for excavation thus omitted on the same basis.

## 1.6 QUALITY CONTROL TESTING

- A. The Contractor shall perform all necessary Quality Control tests and procedures for the performance of the work, in accordance with Section 014000 and this section, to produce the end results specified. The Contractor's Quality Control Agent shall maintain clear and orderly records of such tests and procedures and make them available for field review and approval of the Professional and the Department. The Contractor's bid shall include the cost of all Quality Control tests and inspections.
- B. The Contractor shall submit its plan for Quality Control testing to the Professional and the Department for review and comments. The Professional shall consult with its Quality Assurance Agent in arriving at its opinion.
- C. Quality Control tests shall include tests on fill material, optimum moisture content and maximum density, and field density tests of fill layers. The Quality Control Agent shall comment on the suitability of all subgrades, and the subgrades shall be acceptable to the Consulting Geotechnical Engineer.
- D. Handwritten copies of field test reports shall be provided to the Contractor. They shall be given to the Contractor and inspector within two (2) hours of completion, but in no event shall the technician leave the site without providing the Contractor and inspector with a copy of the test results. This shall include density, % moisture, plan location, elevation, comments, and any other relevant data. Comments shall include any condition that might have an adverse effect on the operations, including weather, drainage, etc.
- E. The Contractor shall request consultation with the Consulting Geotechnical Engineer on any problems that arise during construction. Copies of the daily in-place soil density tests shall be faxed to the consultant by the Contractor through the testing agency within twenty-four (24) hours of the time the tests are made.
- F. The Contractor shall approve each subgrade and each fill layer before proceeding to the next layer. Any area which does not meet density, % moisture, or other requirements at any time shall be suitably reworked and retested by the Contractor at his own expense.
- G. The Professional and/or the Department will perform all Quality Assurance Testing and Inspection Services deemed necessary for the assurance of the Professional and/or the Department. This does not relieve the Contractor of his responsibilities. The Department will bear the cost of Quality Assurance tests and inspections.

## PART 2 - PRODUCTS (Not Used)

## PART 3- EXECUTION

### 3.1 CONSTRUCTION

- A. See current Pennsylvania Department of Transportation Form 408 Specifications, Section 203, Class 1, Class 1A, and Class 1B Excavation, Subsection 203.3.
- B. Surface water and ground water should be prevented from entering excavations, from ponding on prepared subgrades, and from flooding the Project site and surrounding area.
- C. Subgrades shall be protected from softening, undermining, washout, and damage by rain or water accumulation and in no case shall the site be left open and unsealed at the end of the day.

END OF SECTION

SECTION 312333  
TRENCHING AND BACKFILLING

PART 1 – GENERAL

1.1 STIPULATIONS

- A. The specifications sections “General Conditions to the Construction Contract”, “Special Conditions” and “Division 01 – General Requirements” form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.
- B. Refer to section 312316 for related requirements.

1.2 DESCRIPTION

- A. This section includes, but is not limited to:
  - 1. Cutting of paved surfaces.
  - 2. Trench excavation and backfill.
  - 3. Pipe bedding.
  - 4. Excavation and backfill for manholes and inlets.

1.3 SUBMITTALS

- A. Certificates: Delivery tickets.
- B. Compaction equipment list with lift thickness limitations.

1.4 JOB CONDITIONS

- A. Provide dewatering and drainage as required to accomplish work.
  - 1. Conduct discharge from any trench dewatering pumps to natural drainage channels or storm sewers. Discharge must be in accordance with proper erosion and sedimentation control measures.
- B. Comply with applicable codes and permits.
- C. All excavation is unclassified and includes excavation and removal of all materials encountered of whatever nature.
- D. Maintain and provide for wastewater lines, water lines, and utility lines encountered.
  - 1. Make temporary repair as soon as possible.
  - 2. Report damage to utility.
    - a. If utility elects to repair damaged line, cooperate with utility company.
    - b. If utility authorizes repair, repair damaged line and restore service in compliance with regulations of utility company.
  - 3. Responsible for all costs associated with repairing existing utilities damaged by operations.

PART 2- PRODUCTS

2.1 MATERIALS

- A. Stone backfill material: PENNDOT No. 2A aggregate.
  - 1. Comply with requirements of Pennsylvania Department of Transportation Publication 408 Specifications.
  - 2. Natural clean limestone composed of hard, tough, durable, uncoated particles cleaned by washing, free from harmful amounts of clay, silt, vegetation, or other substances determined to be deleterious.
  - 3. Slag is not permitted.
- B. Pipe bedding materials: PENNDOT No. 2B aggregate.

1. Comply with requirements of Pennsylvania Department of Transportation Publication 408 Specifications.
  2. Natural clean limestone composed of hard, tough, durable, uncoated particles cleaned by washing, free from harmful amounts of clay, silt, vegetation, or other substances determined to be deleterious.
  3. Slag is not permitted.
- C. Suitable backfill material:
1. Material removed from trench excavation which is free of cinders, ashes, refuse, vegetable or organic material, boulders, rocks or stones 6" or larger.
  2. Material which can be placed in specific layers.
  3. Material that is not wet, saturated, or frozen.
    - a. Moisture content is within 3 percent of optimum moisture content determined by PTM NO. 106, Method B.
  4. Material that, in the opinion of the owner, is acceptable.

## PART 3- EXECUTION

### 3.1 EXECUTION

- A. Topsoil
1. Topsoil is to be removed and stockpiled on the property from which it was removed in advance of the excavation work.
- B. Pavement removal:
1. Pavement removal is part of the trench excavation.
  2. Dimensions of pavement removal is shown on the drawings.
  3. Saw cut pavement.
    - a. Straight lines parallel with centerline of trench. Cut offsets at right angles to the centerline of trench.
    - b. In state roadways saw cut to dimension required to facilitate excavation. Prior to restoring roadway saw cut one foot back from edge of trench and remove detached pavement.
- C. Excavate trench to depth and grade for pipe invert plus additional 6 inch depth for bedding material.
1. Rock, hard shale, or unyielding material encountered in trench.
    - a. Excavate for full width of trench below proposed elevation of bottom of pipe for a depth of 3 inches in addition to depth specified for bedding material.
  2. Unstable material encountered in trench bottom.
    - a. Remove from under pipe for full width of trench to a depth of 3 inches into suitable material.
  3. Replace with suitable bedding material.
    - a. Compact to satisfactory density.
- D. Place excavated material in a manner that will not obstruct the work, sidewalks, driveways or other structures.
- E. Trench width:
1. State roadways.
    - a. 48 inch and less outside pipe diameter:
      1. Outside diameter of pipe, measured at bell, plus 12 inches on each side of pipe.
    - b. Over 48 inch inside pipe diameter:
      1. Outside diameter of pipe, measured at bell, plus 15 inches on each of pipe.
  2. Other areas.
    - a. Maximum width equal to nominal size of pipe plus 16 inches.
  3. Shape trench walls vertical from trench bottom to minimum 1 foot above pipe.
- F. Support and maintain all underground and surface structures, drains, sewers, and other obstructions encountered during construction.
- G. Blasting for excavation permitted only after securing written approval from owner.

- H. Protect all trees, shrubs, fences, and other property and surface structures during construction unless their removal is shown on drawings or approved by owner.
  - 1. Cutting of trees roots or branches: As approved by owner.
- I. Support trench walls to comply with all codes.
- J. Maximum length of trench opened: 100 feet.
- K. Rock excavation: 20 feet in advance of pipe.

### 3.2 BEDDING

- A. Install required depth of bedding material.
- B. Provide holes for bell or couplings at each joint large enough for joint assembly so that pipe barrel will lie flat on trench bottom.
- C. Install stone backfill material in 4 inch layer to 6 inches above pipe.

### 3.3 BACKFILL AND COMPACTION

- A. Install backfill material in 8" lifts and compact with approved vibratory compaction equipment.
- B. Backfill and compact remainder of trench as shown on drawings.
  - 1. Place material in uniform layers as indicated on drawings. Layer depths shown are maximum depths allowed when using compaction equipment as approved by PENNDOT Project Office Manual, Publication.
  - 2. If required compaction is not achieved, depth of layers shall be reduced.
- C. Maximum allowable height for backfill material to be dropped into trench when pipe covered with at least 12 inches of stone backfill: Five feet from top of existing backfill in trench.
- D. Compact backfill materials to percent of maximum dry weight density determined by PTM No. 106.
  - 1. State roadways - 100%.
  - 2. Borough and Township roadways, paved areas, driveways, and sidewalks - 100%.
  - 3. Stabilized areas - 90%.
  - 4. Other area - 85%.
- E. Compaction tests may be performed at owners and/or engineer's option at a frequency not to exceed one per 200 feet of trench.
  - 1. Testing to be PENNDOT PTM No. 112 (sand cone method) or PENNDOT PTM No. 402 (Nuclear method), as determined by the engineer.
- F. Spread topsoil.

END OF SECTION

## SECTION 312500

### EROSION AND SEDIMENTATION CONTROLS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 DESCRIPTION

- A. Furnish, install, and maintain temporary and permanent soil erosion and sedimentation control measures as required throughout construction period.
- B. Accelerated erosion control shall be corrected with suitable measures by the contractor.
  - 1. Control accelerated erosion at its source and maintain it under control at all times.
  - 2. Prevent sedimentation from leaving the construction sites.
- C. Refer to the Erosion and Sediment Pollution Control Plan for Chapter 93 designation(s) for stream(s) in the project area. High Quality (HQ) and Exceptional Value (EV) designations require more stringent erosion and sediment pollution control practices.
- D. Approved Erosion and Sediment Pollution Control Plan to be kept onsite at all times. Contractor to follow all control measures set forth in plan.

##### 1.3 PROJECT CONDITIONS

- A. Erosion control measures needed to check accelerated erosion should be placed or implemented prior to start of excavation or grading.
- B. Minimize the area and time soil will be left bare by construction.
  - 1. Any disturbed areas where soil has been exposed and is potentially subject to accelerated erosion will immediately be temporarily stabilized.
  - 2. Permanent seeding and mulching of all disturbed areas will be done immediately after final grading is completed.
    - a) For slopes 3:1 or greater erosion control matting will be used and installed per manufacturer's instructions.
- C. Site grading shall be completed and stabilized before the winter months.
  - 1. If site grading is performed during winter months and seeding cannot be performed, place 3 tons of grass hay or cereal straw per acre until permanent seeding can be performed in the spring.
- D. Silt barrier fence is to be placed perpendicular to the natural drainage paths and at the entrance of cross pipes which may receive sediment laden runoff from the project. Silt barrier fence is not to be placed within watercourses.
- E. Sediment in runoff will be trapped until disturbed areas are stabilized.
- F. Stripping vegetation, regrading, or other development will be done in such a manner so as to minimize erosion.
- G. If offsite disposal areas are needed, the contractor will prepare an Erosion and Sediment Pollution Control Plan for these areas. The Plan will be submitted to the local Conservation District for compliance with applicable regulations (Earth Disturbance, wetland, floodplain, etc.).
- H. If hazardous materials are to be used in the project area, the contractor will be responsible for preparing a Preparedness Prevention and Contingency (PPC) Plan in accordance with 25 Pa. Code Section 101.3.
- I. The contractor will be required to enter into the attached Co-permittee Agreement and to sign a copy of the Co-permittee Application Form (DEP Form 3600-FM-WQ0228) prior to commencement of construction activities.

#### PART 2 - PRODUCTS

## 2.1 MATERIALS

- A. All seeding, soil supplements, and mulching requirements shall be according to the seeding specification and E&S Plan.

## PART 3 - EXECUTION

### 3.1 TRENCHING - GENERAL

- A. The soil removed in trenching will be placed on the upslope side of the trench. Topsoil will be stockpiled separately for placement during final grading.
- B. At no time will trench be opened more than 300 feet in advance of pipe laying and at no time will pipe laying be more than 100 feet in advance of backfilling.
- C. All excavated material will either be used as backfill or hauled away.
- D. Trench dewatering, if required, will be performed in accordance with the Construction Details and the Erosion and Sedimentation Pollution Control Program manual.
- E. Backfilled trenches not located on shoulders or roadways will be seeded and mulched 15 days after backfilling.
- F. Place silt barrier fence perpendicular to all backfilled trenches which are located coincident to an existing roadway swale.
- G. Minimize the disturbance or uprooting of existing trees and vegetation along and in the vicinity of the streams to preserve stream bank stability.
- H. At the close of each working day, the following items will have been complied with:
  - 1. The conduit/main will be installed to within 50 feet of the end of the open trench.
  - 2. All installed conduit/main will be backfilled.
  - 3. The last section of conduit/main installed each day will be temporarily capped to prevent silt from being deposited in the conduit/main in the event of an overnight rain.
  - 4. Bales will be placed end to end (or side by side) so as to cover the open trench. (Primarily a safety measure for use in areas where children will be at play, however, it will shed some water and dissipate the force of raindrops striking the trench floor, thus reducing the amount of silt in suspension.)
- I. Trenching in advance of conduit/main installation will cease at a point no less than 10 feet from any stream/ditch bank and resume at a point no less than 10 feet beyond the opposite stream/ditch bank.
- J. Special care must be taken while working in wetland areas.
  - 1. Staging areas must be on an upland area a minimum of 50 feet from the edge of the wetland.
  - 2. Topsoil must be carefully removed and stockpiled separately from the excavated material.
  - 3. Do not use fertilizer or lime in wetland areas.
  - 4. Fuels, hazardous materials, or herbicides shall not be stored within 100 feet of a wetland.
  - 5. When working in wetland areas, orange construction fence to be placed along the edge of the temporary easement area. When working near wetlands, orange construction fence to be placed along wetland area.

### 3.2 MAINTENANCE

- A. The facilities for erosion and sedimentation control shall be maintained for their designed operation to insure adequate performance.
  - 1. Sedimentation control structures shall be cleaned when an accumulation of sediment has reached one half the depth of the sediment structure.
  - 2. The sediment shall be removed and disposed of in such locations that the sediment will not again erode into the construction area or into natural waterways.
  - 3. All temporary erosion control structures shall be removed after the construction areas have been stabilized.

4. During construction, any erosion problems that may begin in unprotected areas must be remedied.

END OF SECTION



SECTION 312600  
NPDES PERMIT AND APPLICATION

PART 1- GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 DESCRIPTION

- A. The NPDES permit and application, containing specific references and requirements of the Pennsylvania Department of Environmental Protection is hereby incorporated by reference into the contract documents.
- B. Copies of the NPDES permit and application are available for examination by interested parties at the office of the owner.
- C. A copy of this permit including the erosion control plan should be maintained by the contractor at the job site.

1.3 PERMIT OBLIGATIONS

- A. The contractor, as operator of construction activity, and implementor of erosion control plan, must become a NPDES co-permittee with the current NPDES permittee (Owner). This process will occur via a PaDEP "transferee/co-permittee" application form and will be effectuated prior to the Owner's execution of the contract. Acknowledgement of co-permittee must be received from the County Conservation District prior to commencement of construction activity.
- B. The approved NPDES permit requires the contractor to prepare a "preparedness, prevention, and contingency plan" in conformance with regulations and guidelines established under the National Pollutant Discharge Elimination System stormwater permitting program. This plan must address usage and storage of chemicals, solvents, and other hazardous waste or materials with the potential to cause accidental pollution during earthmoving or other construction activities (i.e. equipment refueling operations). This plan must be submitted to the Owner, the Engineer and the County Conservation District prior to commencement of construction activities.
- C. The contractor must observe all instructions stipulated in Section 312500 and the Erosion and Sediment Pollution Control Plan.
- D. As NPDES co-permittee, the contractor will be fully and exclusively responsible for installation, maintenance, and, if appropriate, removal of all erosion control facilities stipulated within the NPDES permit. In addition, he will accept liability incurred for neglect of observation of all conditions of the approved NPDES permit.

PART 2- PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

**CO-PERMITTEE AGREEMENT  
ASSUMPTION OF RESPONSIBILITY UNDER PERMIT FOR DISCHARGE  
OF STORM WATER FROM CONSTRUCTION ACTIVITIES**

\_\_\_\_\_ (Permit number)

\_\_\_\_\_ (Name of Facility/Project)

\_\_\_\_\_ (Municipality)

\_\_\_\_\_ (County)

The following parties agree to joint ownership and operational control under the above-referenced permit. (Co-permittee name & address) hereby assumes, effective (date) responsibility, coverage and liability under the permit for any obligations, duties, responsibilities, and violations under said permit. (Co-permittee name & address) shall remain liable under the permit for violations of the permit up to and including (date) **AND** until the (Conservation District/Regional Office) acknowledges the Co-Permittee/Transferee Form. The Department may hold (current permittee) and (co-permittee) jointly and severably liable under said permit for any breach of permit obligations, responsibilities, or violations in which both parties participated.

The limits of permit responsibility, coverage, and liability for the transferee include all work areas to be performed by the Contractor for the New Public Works Facility for the Township of Ferguson.

\_\_\_\_\_  
(Current Permittee)

\_\_\_\_\_  
(Co-permittee)

\_\_\_\_\_  
\_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

SECTION 312700  
STREAM CROSSING

PART 1- GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 DESCRIPTION

- A. Installation of pipeline or boring beneath a waterway.
- B. Refer to section 312316 for related requirements.

1.3 REGULATORY AGENCIES

- A. Work is subject to supervision by representative of Pennsylvania Department of Environmental Protection and the Soil Conservation District.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

- A. Contractor shall be apprised of all the provisions and conditions of the Encroachment Permit and the Erosion and Sedimentation Control Plan.
  - 1. Contractor will be given a copy of the permits for his files.
- B. A permit must be secured from Pennsylvania Fish Commission if explosives are needed.

PART 2- PRODUCTS

2.1 MATERIALS

- |    |                                   |                               |
|----|-----------------------------------|-------------------------------|
| A. | Encasement concrete, if required: | PENNDOT 3750 PSI, HES         |
| B. | Steel Casing, if required:        | AWWA C 200-80, ASTM A53.      |
| C. | HDPE, if required: I              | PS 3408/3608/4710 DR11 160psi |

PART 3- EXECUTION

3.1 PERFORMANCE

- A. Comply with rules and regulations of Pennsylvania Department of Environmental Protection and Pennsylvania Fish Commission.
- B. Take sufficient precautions to prevent pollution of streams with fuels, oils, bitumens, calcium chloride, or other harmful materials.
- C. Schedule and conduct construction operations to prevent the pollution of streams with sediment or other deleterious materials.
- D. Remove construction debris, excavation material, brush, rocks, and refuse incidental to the work entirely from stream channel and remove from site.
- E. Utilize coffer dams, levees, diversion trenches, etc., to obtain the required stream diversion and erosion control.
- F. Notify the Department of Environmental Protection prior to the commencement of work.
- G. Trench plug to be placed as shown on detail drawing.
- H. After stream-bed excavation work is completed, return surface water flow to its original course (if applicable).
- I. Riprap or place jute matting on disturbed stream banks utilizing the appropriate size material for stream conditions, as per engineer instructions (if applicable).

END OF SECTION

**SECTION 31 32 23**  
**PROOF DRILLING AND GROUTING OF KARST FEATURES**

**PART 1 – GENERAL**

**1.1 DESCRIPTION**

- A. Work shall consist of Drilling through overburden soil and rock to verify the absence of voids in the subsurface at predetermined locations within the structure footprint as specified herein. Pressure grouting each of the proof-drilling locations to fill and stabilize any encountered voids, open joints and fissures, and loose rock or soil prior to repair work.

**1.2 WORK INCLUDED**

- A. The specified proof drilling and grouting program identified herein is the minimum to be performed. The total quantity of drilling and grouting to be performed is dependent upon the information gained as work progresses. The right is reserved to increase, or decrease, the amount of any item under the contract. The Contractor will not be allowed any increase in the unit prices bid for proof drilling and grouting by reason of any changes in the drilling conditions, change in the amount of work or materials actually involved.
- B. Proof-drilling shall be performed at the locations shown on the Proof-Drilling and Compaction Grouting Location Plans that have not been previously investigated. In general, proof-drilling will be performed every 20 feet long the length of the cantilevered retaining/foundation wall along gridline A and at every building column location not previously proof-drilled. Where indicated on the plans, some locations have already been investigated and require grouting. Where proof-drilling has not already been performed as part of the design effort, locations should be proof-drilled and, if voids are encountered during proof-drilling, voids should be grouted. Additional drilling locations may be required based on the results of the proof-drilling effort.
- C. The contractor will be responsible for field locating all utilities and modifying the grouting plan, with approval from the engineer, to avoid damage to any existing in service or abandoned pipes, utilities, or other underground structures.
- D. Drawings and General Provisions of the Contract, including General and Supplemental Conditions, and Division 1 Specifications, apply to the work in this specification.

**1.3 SITE CONDITIONS**

- A. The Contractor shall examine the areas and conditions under which the proof drilling and The Contractor, by careful examination, shall inform himself as to the nature and location of the work; the conformation of the ground, the nature of the subsurface conditions; the locations of the groundwater table; the character, quality and quantity of the materials to be encountered; the character of the equipment and facilities needed preliminary to and during the execution of the work; the conditions of adjacent structures and utilities and all other matters which can in any way effect the work.
- B. The site is located in karst geology. The subsurface conditions at the site generally consist of residual silt and clay soils over highly variable limestone rock. Voids and highly fractured limestone rock was encountered in boreholes or observed in the geophysical studies at the site. Refer to the geotechnical soil boring logs and geophysical studies for additional details regarding subsurface conditions.
- C. Soil and rock samples taken from the borings are available for the Contractor's review.

- D. The Contractor shall be held to have visited the site and to have familiarized himself with the existing conditions of adjoining utilities and structures.
- E. The Contractor shall make his own deductions of the subsurface conditions which may affect the methods or cost of the work hereunder, and he agrees that he will make no claims for damages or compensations, except as are provided under the agreement, should he find conditions during the progress of the work different from those as calculated and/or anticipated by him. Additional borings and other exploratory operations may be performed by Contractor, at the Contractor's option and following the Owner's approval. No change in the Contract Sum will be authorized for such additional exploration undertaken by the Contractor.
- F. The Contractor shall investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affecting transportation to, ingress and egress of the site of the work. The Contractor shall conform to all State and Federal regulations concerning the transportation of materials to and from and at the job site and shall secure in advance such permits as required.
- G. Proof drilling and grouting operations shall adhere to all methods and standards described in this Specification.

#### 1.4 APPROVED CONTRACTORS

- A. The Proof drilling and grouting Contractor (the Contractor) shall have a minimum of 5 years of continuous experience in proof drilling and pressure grouting solution cavities in similar karst bedrock formations.
- B. The Contractor must demonstrate successful completion of at least 10 projects of similar scope and magnitude. No Contractor will be considered acceptable without a minimum of five years of experience in grouting of karst solution cavities.
- C. Because of the specialized nature of the grouting operation required to perform the stabilization, proposals will only be accepted from qualified grouting contractors. The grouting Contractor shall submit a list of grouting projects undertaken in the past five years with their bid. The following information shall be provided for each project. for each project:
  1. Name and location of project
  2. Total dollar value of the Contractor's work
  3. Quantity of grout placed
  4. Equipment used
  5. Grout mix design
  6. Drilling methods and depths
  7. References for owner and engineer including name and phone number.

#### 1.5 REFERENCE STANDARDS

- A. AASHTO T119 – Standard Test Method for Slump of Hydraulic Cement Concrete
- B. ASTM C940 – Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory
- C. ASTM C939 – Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
- D. Geotechnical Exploration
  1. Geotechnical explorations have been performed at the site; copies of geotechnical boring logs and geophysical studies are available from the Owner. The Contractor shall note that all information is provided for information only and no claim from the Contractor will be entertained for any accuracy or discrepancy in the same.
  2. The Contractor is to satisfy himself that the soils and rock data contain sufficient information for bidding and executing all work.

3. The Contractor shall perform any additional investigation he requires to satisfy himself of the nature of the subsurface conditions. Any investigation must be approved by the Owner.

## 1.6 CERTIFICATIONS AND SUBMITTALS

- A. Work shall not begin until the appropriate submittals have been received and reviewed, in writing, by the Engineer. Contractor shall allow the Engineer ten working days to review each submittal after a complete submittal has been received.
- B. The following shall be submitted by the grouting contractor:
  1. QA/QC plan detailing the required information in Section 1.4, including resumes of the management, supervisory, and key personnel, for approval by the Owner's representative.
  2. QA/QC plan identifying how Contractor will verify grout flow and pressure and what measuring equipment will be used for this purpose.
  3. A schedule detailing the sequence, and estimated time of completion of all phases of work under this Section.
  4. A method statement summarizing the intended proof-drilling and grouting procedures including equipment to be used.
  5. A ground movement monitoring plan, including methods for monitoring movement of roadways or utilities within 50 feet of the work.
  6. Mix designs for the project indicating sources and types of grout materials, with proportions by weight, and field test data from previous projects indicating compressive strength and slump.
  7. If the grouting contractor intends to deviate from the mix requirements in this specification, evidence of satisfactory use of the proposed material from past projects with similar karst soil and rock conditions shall be submitted with the bid for approval by the Engineer.
  8. Minimum and maximum grouting pressures to be used for the initial grouting.
  9. Provide grout plant/supplier name and location if ready mix grout is to be used. Provide grout mix design for any alternative grout mixes the Contractor may propose based on the site-specific project subsurface conditions.
  10. The Contractor shall submit the name of each material supplier and specific type and source of each material. Any change in source or material type throughout the job requires approval of the Owner and the Engineer.
  11. Work procedures and control criteria (including volumes and pressure for each stage).
  12. Calibration certificates for pressure gages.
- C. The following shall be submitted to the Owner's representative by the grouting contractor within 24 hours of the end each shift:
  1. Accurate daily records of all grout casing installation, grouting quantities, including stage data, volume, pressure, and depth for each grout casing location.
  2. Any change in the predetermined grouting program necessitated by a change in the subsurface conditions.
  3. Verification of rock depth and quality during drilling, as evidenced by drilling resistance recorded on drilling logs.
  4. Results of movement monitoring.

## PART 2 – MATERIALS AND EQUIPMENT

### 2.1 MATERIALS

- A. The Contractor shall provide all the necessary materials and store a sufficient quantity of all materials on-site as necessary to ensure that the grouting operations will not be delayed by lack of materials.
- B. Grout

1. The grout shall be a mixture of cement, water, and sand and may contain other non-shrink agent, water reducing agent or other additives approved by the Engineer.
  2. As a minimum, the Contractor shall provide mix designs for 2 inch and 4 inch slumps. Each mix design shall include proportions of materials by weight, testing by an independent agency including compressive strength.
  3. Grout shall have a minimum compressive strength of 400 PSI at 28 days.
  4. The mix ratio shall be adjusted for field conditions as directed by the Engineer. Grout with a slump greater than 4 inches at the injection point will be rejected.
  5. The Contractor shall have the ability to modify the slump mid-location depending on the stratum being injected (i.e. rock, soil, void, etc.).
  6. Ready-mixed grout is not an acceptable material.
- C. Portland Cement: Use ASTM C150 Type II
- D. Sand: Fine aggregate shall be sand with a fines content (percent passing No. 200 sieve) of not less than 10 percent and not more than 30 percent. Natural fines may be supplemented with fly ash.
- E. Water: Use clean, uncontaminated, potable water.
- F. Fly Ash: Conform to the requirements of AASHTO M 295, Class C, F, or N, except limit Loss on Ignition to a maximum of 6.0%.
- G. Water Reducing Agent: A compound possessing characteristics which will increase the flowability of the mixture, assist in dispersal of the cement grains, and neutralize the setting shrinkage and bleed of the grout is acceptable.
- H. Bentonite or other high plasticity clays are prohibited.

## 2.2 MATERIAL DELIVERY, STORAGE AND HANDLING

- A. The grout may be delivered to the site in ready-mix trucks or may be mixed on-site provided the proof-drilling and grouting operations are not delayed by the mixing operations.
- B. Store sufficient quantities of each material at the site to ensure that grouting operations will not be delayed by material shortages.
- C. Properly store all bulk and bagged materials to prevent damage from moisture or contamination. Store all materials at temperatures above freezing. Discard any cement, sand, mineral filler, and water reducing agent that is damaged by moisture, contamination or freezing.
- D. Upon discharge into the pump hopper or holding tank, the grout must be continuously agitated. Mixed grout may not be held in the agitator for more than 1.5 hours unless a set retarder, approved by the Engineer, is used. Any grout not pumped within the time limit shall be disposed of by the Contractor at no additional cost to the Owner.

## 2.3 EQUIPMENT

- A. All equipment shall be in first-class working condition to assure continuity of the work. Equipment deemed by the Engineer to be unsatisfactory shall be immediately removed from the site.
- B. Proof-drilling Rig
  1. Proof-drilling shall be accomplished using a conventional air-rotary or percussion or equivalent drill rig and associated air compressor of the type or types approved by the Engineer.
  2. The drill rig shall be of sufficient size and capacity to carry on drilling operations in an efficient manner and provide holes of adequate size.
  3. The drill rig shall have a sufficient number of drill rods to drill to a minimum depth of 100 feet.



4. Provide supplies for air-rotary or percussion drilling such as casing, drill rods, air compressor, piping, tools, and power required for drilling.

#### C. Casing

1. Provide casing to advance and stabilize the hole and facilitate grout placement.
2. Casing shall consist of flush-joint steel casing.
3. Casing shall be strong enough to resist the forces of drilling, grouting, and extraction.
4. Maximum casing length of 5 feet will be permitted to allow for accurate readings of pressure gage mounted to the casing at the top of the hole.

#### D. Grouting

1. The Contractor shall provide all materials and equipment (e.g. temporary casing, connections, hoses, etc.) including mobilization, demobilization, cleanup, waste disposal and other subsidiary items considered incidental to grouting.
2. The mixer shall be a continuous auger type to ensure complete uniform mixing of the materials used and shall be of sufficient capacity to continuously provide the pumping unit with mixed grout at its normal pumping range. The mixer must be capable of volumetrically proportioning the grout materials.
3. Pump:
  - a. Provide a positive displacement grout pump, piston-type with a maximum material cylinder diameter of 4.5 inches, and a constant controllable rate of output.
  - b. The pump should be capable of injecting stiff cement grout with a slump of 0.5 inches to 2 inches through grout lines and pipes with a minimum diameter of 2 inches and at controllable rates from 0.2 cubic feet per minute (cfm) to 2 cmf at pressures of at least 600 pounds per square inch (psi), measured at the riser.
  - c. The volume displacement rate of the pump (cubic feet per stroke) shall be calibrated to by pumping into a container of known volume at least 1 cubic foot or larger.
  - d. The pump shall be equipped with an operating stroke counter to provide a record of volume injected in each stage.
  - e. Provide Equipment shall be provided for the calibration of the volume measurement device and calibration should be performed at the start of work and at other times as required by the Geotechnical Inspector.
  - f. An adequate communication system shall be maintained between the pumping location and the injection location. As an alternative, the contractor may provide a remote control system to allow full control (start, stop, flow rate, and reversing) of the pump, directly by the grouting technician from the injection point.
4. Pressure Gages
  - a. Provide a calibrated pressure gage, located at the top of the grout hole.
  - b. Pressure gage shall have a minimum face diameter of 2 inches.
  - c. Pressure gages shall have a capacity of zero to at least 600 PSI, but no greater than 1,000 PSI.
  - d. Pressure gages shall have maximum 20 PSI divisions, with a minimum accuracy of one-half division.
5. Material Quantities Measurement
  - a. Provide method and equipment for accurate and rapid measurements of grout quantities injected and quantities of water, cement, sand and admixtures used. Demonstrate and calibrate all measurement systems and equipment prior to the start of work.

## PART 4 – EXECUTION

### 4.1 GENERAL

- A. The Contractor is solely responsible for all damaged and lost tools and equipment at no cost to the Owner.

- B. Prior to the start of any work, locate and identify existing utilities that are to remain and protect them from damage.
- C. The total quantity of drilling and grouting to be performed is dependent upon the information gained as work progresses.
- D. The Engineer may add or deduct grout holes based on the conditions encountered.
- E. Primary proof drilling shall be performed prior to secondary location. Primary proof drilling locations will be spaced as shown on the Contract Drawings.
- F. Secondary proof-drilling shall be performed at the locations specified by the Engineer in the field whenever a high volume of grout is pumped into primary drill holes.
- G. If a primary proof-drill hole takes a volume of grout in excess of about 4 to 5 cubic yards, the Engineer may require additional proof-drilling locations be drilled and grouted in that vicinity. The additional holes shall be at locations as directed by the Engineer in the field extending out from that drill hole. Additional holes shall be drilled and grouted following this procedure until the grout intake per hole drops significantly as acceptable to the Engineer.

#### 4.2 PROOF-DRILLING

- A. Proof-drilling shall be performed at the locations shown on the Proof-Drilling and Compaction Grouting Location Plans. In general, proof-drilling will be performed every 20 feet long the length of the continuous wall footings and at every building column location where proof-drilling has not already been performed as part of the design effort. If voids are encountered during proof-drilling additional drilling locations will be required.
- B. Proof-drilling shall be performed using an air rotary percussion drill with a minimum 2-inch diameter cutting head.
- C. Proof-drilling should extend to a minimum depth of 30 feet below proposed bottom of foundation elevation or where rock is encountered, the rock should be drilled for a length of at least 10 feet below foundation bearing elevation to verify it's integrity. Where rock is encountered within 5 feet of proposed foundation bearing elevations, the rock should be drilled for a minimum depth of 10 feet to verify it's integrity and identify any voids. Do not extend holes deeper than the criteria herein, unless directed by the Engineer.
- D. If voids are encountered additional proof-drilling should be performed. The additional proof-drilling holes should be performed equidistant between the initial hole and the next proof-drilling or compaction grouting point or at the Geotechnical Engineer's direction.
- E. Contractor shall ensure that a plumb hole is attained when drilling primary holes. As required, the Contractor shall support the hole with temporary casing advanced by driving or jacking.
- F. The Contractor shall aid the Engineer in the preparation of drilling logs by providing information pertinent to drilling such as depth of overburden and rock penetrated, methods used to advance the hole, methods used to advance the casing, length of casing installed, location of voids encountered, and depths of loss of air pressure with its associated elevation.
- G. Casing and drill rods shall be marked clearly with 1-foot intervals so the depth of the hole can easily be determined at all times.
- H. Casing shall be set tightly within the drill hole to minimize the annulus. If necessary, backfill the annulus with fine sand. An annular space of more than ¼-inch around the casing will not be permitted.

#### 4.3 GROUTING

- A. Following proof-drilling any voids that are encountered should be filled with grout.
- B. Regardless of the bearing materials encountered during proof-drilling, the proof-drilling holes shall be grouted to proposed foundation bearing elevation following proof-drilling to seal the subsurface materials and reduce the potential for water infiltration and the formation of sinkholes.
- C. Grouting of proof-drill holes shall be performed concurrently with the actual proof-drilling operations. Proof-drill holes shall not be left open for more than 5-days, unless approved by the Engineer.
- D. Each and every proof-drill hole shall be grouted completely in the following sequence:
  - 1. Primary grout holes shall be grouted first.
  - 2. Begin grouting holes on the outside of the limits of grouting and proceed inward.
  - 3. Drill and grout secondary grout holes, if deemed necessary based on field conditions and as directed by the Engineer.
- E. Grouting of all proof-drill holes shall be in accordance with the following:
  - 1. Grout shall be pumped into the proof-drill hole through a metal casing with a sufficient length so that the casing may be inserted the full depth of the grout hole. This casing shall be of sufficient strength to withstand the grouting pressure. The casing shall be withdrawn as the grouting is in progress once the criteria given in this specification have been achieved.
  - 2. All the casing fixtures/connections shall be of adequate capacity to withstand maximum grouting pressure. Breakdown of a connection shall not be accepted as a criterion for termination of grouting a drill-hole.
  - 3. The initial grout mix shall be one of the submitted and approved mix designs.
  - 4. Grout shall be pumped into the hole at each depth decrement until the desired pressure has been attained, but must be terminated if ground heave is observed or grout is observed at the surface. The grout casing shall then be raised 1 foot and the procedure repeated incrementally up to the ground surface. The grouting shall continue until the grout hole refuses to take any amount of grout at the desired pressure.
  - 5. Pressure grouting shall be performed from the bottom of the hole to a distance of 5 feet below grade. Above the cutoff depth for pressurized grouting, extract the remaining casing while at the same time injecting just enough grout to backfill the remaining 5 feet of the drill hole. Where rock is encountered at a depth of 5 feet or less below the ground surface, do not pressure grout the soil zone above rock.
  - 6. Grouting pressures will vary with the conditions encountered in respective holes and the pressures used shall be as directed by the Engineer. Minimum grout pressures of about 10 PSI range should be anticipated.
  - 7. The pumping rate may undergo adjustment with every hole because of variation in the subsurface conditions. The pumping rate shall not exceed 2.0 cubic feet per minute unless approved by the Engineer. A pumping rate of up to 4.0 cubic feet may be used, if all of the following conditions are satisfied:
    - a. The top of the grout stage is at least 2 feet below top of rock
    - b. The top of the grout stage is more than 25 feet below ground surface
    - c. Injection pressure remain below 50 psi at the top of the casing
    - d. A void is noted on the drilling log within the limits of the grout stage
  - 8. Grouting Refusal Criteria – A grout stage will be judged complete when one of the following refusal criteria is met:
    - a. A volume of 81 cubic feet (3 cubic yards) is injected at pressures less than 20 PSI as measured at the riser
    - b. A volume of 27 cubic feet (1 cubic yards) is injected at pressures between 20 to 60 PSI as measured at the riser
    - c. A volume of 13.5 cubic feet (0.5 cubic yard) is injected at a pressure between 60 to 120 PSI as measured at the riser.
    - d. A volume of 4 cubic feet (0.15 cubic yard) is injected at a pressure between 120 to 500 PSI as measured at the riser.
    - e. Pressure reading of 500 PSI or greater is measured at the riser.
    - f. Terminate the grout hole if grout is observed flowing from the top of the drill-hole or an adjacent drill-hole.

- g. Terminate the grout hole if ground movement (heave) is observed, as directed by the Engineer.
- 9. The Contractor will be required to furnish such pumps as may be necessary to care for wastewater and grout from his operations. The Contractor shall legally dispose of, off-site, all waste resulting from his operations.
- 10. The Contractor shall maintain the grouting equipment to ensure accurate pressure readings at the ground surface for each grouted hole and the actual volume of grout pumped in each hole.

#### 4.4 FIELD QUALITY CONTROL

- A. All grouting shall be performed under the observation of the Engineer.
- B. Owner's testing laboratory will perform compressive strength tests of grout:
  - 1. Testing lab shall cast minimum size 3 inch by 6 inch grout test cylinders for strength testing. The cylinders/cubes shall be marked with the date and time taken.
  - 2. Samples for testing shall be collected on the first day of grouting, and as requested by the Owner or Engineer.
  - 3. Strength tests shall be performed on two cylinders/cubes at 7-days and three cylinders/cubes at 28-days with one sample held.
- C. The Owner's Engineer will perform slump tests (AASHTO T119) on grout as follows:
  - 1. once for every 10 cubic yards of grout injected,
  - 2. at any change in mix design,
  - 3. at least once during each grout shift.
- D. Grout mix proportions will be verified by the Contractor at least once daily.
- E. Daily records shall be maintained by the grouting contractor and submitted to the Engineer within 24 hours of each shift. The records shall include, at a minimum, soil and rock drilling conditions and depths, depths of voids, grout take at each stage, remarks concerning movement monitoring and other pertinent information about drilling and grouting.

#### 4.5 MOVEMENT MONITORING

- A. Ground, Roadway, Structure and Utility Monitoring
  - 1. Continually monitor adjacent roadways and utilities within 50 feet of the work during drilling and grouting.
  - 2. Monitor ground movements immediately adjacent to the grout injection point and within a minimum 10 foot radius from the injection point.
  - 3. Ground movement monitoring shall be performed by optical survey, rotating laser level or other approved means to monitor movement to an accuracy of at least 0.01 feet or less.

#### 4.6 SITE MAINTENANCE AND RESTORATION

- A. Site Maintenance: The Contractor shall keep the site clean and orderly at all times. Site improvements shall be protected from damage or becoming soiled. Spilled grout shall be promptly picked up and moved to an appropriate waste storage area. Hoses, delivery lines, and other items that are not in immediate use shall be neatly stored in a manner that will not impede the ongoing work or site access. All trash, used cement bags, etc. shall be collected and neatly stored for legal disposal off site. Water and waste grout shall be promptly collected and disposed of legally.
- B. Site Restoration: Remove and properly dispose of all excess grout or other debris generated as part of the work. Fill all holes with grout to the surface through the casing as the casing is extracted. Repair damage to pavements and utilities caused by grouting. Restoration must be completed prior to final payment.

## PART 5 – QUALITY CONTROL

### 5.1 QUALITY CONTROL TECHNICIAN

- A. The Contractor shall provide at least one supervisory person, with a minimum experience of five years with similar work, who shall be present at all times during execution of the work and who shall be thoroughly familiar with the type of work being performed and its best methods for completion. This person shall have the authority to act on behalf of the Contractor.
- B. The Contractor shall comply with any provisions of all applicable codes, regulations and standards.

## PART 6 – QUALITY ASSURANCE

### 6.1 QUALITY ASSURANCE BY ENGINEER

- A. An Engineer familiar with the requirements of the project plans, specifications and geotechnical exploration, selected and paid by the Owner, will perform construction observation on site to determine if the work is in accordance with the specifications and plans, based on conditions encountered, visual observation, and judgment. This observation will not relieve the Contractor of his responsibility to complete the work in accordance with the plans and specifications.
- B. Visual field observations shall be performed by the Engineer as part of the construction quality assurance requirements.
- C. The Engineer will prepare daily field reports summarizing the construction and/or material testing activities that indicate field observations, drilling and grouting quantities and if the requirements of the specification are achieved and identify any deficiencies. These reports shall be submitted to the Owner for review by the Engineer of Record.
- D. The Engineer shall submit detailed logs and test reports necessary to facilitate any corrective design requirements by the Engineer of Record. The contents and format of all logs shall be as directed by the Engineer of Record.
- E. The Engineer shall issue Non-Conformance Reports (NCR) for any construction that does not meet the project requirements. Contractor must address all NCRs with proposed correcting action for approval by the Engineer of Record.
- F. No work shall be performed without the Engineer present. All costs related to extra verification due to inadequate procedures shall be paid for by the Contractor at no additional expense to the Owner. The Owner reserves the right to direct any verification that is deemed necessary. Contractor shall provide free access to the site for observation by the Owner and Engineer.

## PART 7 – RESPONSIBILITIES OF THE GENERAL CONTRACTOR

### 7.1 SITE PREPARATION AND PROTECTION

- A. The General Contractor shall retain a professional surveyor registered in the Commonwealth of Pennsylvania to locate and protect underground and aboveground utilities and other structures from damage during proof drilling and grouting.
- B. Each proof-drilling location stake shall be clearly marked with point name and ground surface elevation.

- C. The General Contractor will provide site access to the Contractor after earthwork in the area has been completed. A working surface shall be established and maintained by the General Contractor to provide wet weather protection of the subgrade and to provide access for safe and efficient operation for proof drilling and grouting operations.
- D. Prior to, during and following for proof drilling and grouting operations, the General Contractor shall provide positive drainage to protect the site from wet weather and surface ponding of water.

#### PART 8 - MEASUREMENT AND PAYMENT

- 8.1 Payment for the items specified below constitutes full compensation for all plant, labor, equipment, and materials to satisfactorily furnish, place, and maintain the items of work. Materials, equipment or operations not specifically noted for payment, but necessary for satisfactorily completing the final work, are considered incidental to the various items of work.
  - A. Item No. 1: MOBILIZATION – EACH: This item will include mobilization of personnel and equipment necessary for grouting. Materials, equipment or operations not specifically noted for payment, but necessary for satisfactory completion of the work, are considered incidental to this work item.
  - B. Item No. 2: DRILLING AND INSTALLATION OF CASING - LINEAR FOOT: No payment will be made for holes unsuitable for grouting or failing to meet layout and/or tolerance requirements.
  - C. Item No. 3: SOIL-CEMENT GROUT - CUBIC YARD: No payment will be made for grout wasted, or because of mechanical failure and scheduling conflict, or grout rejected for failing to meet slump or strength requirements.

END OF SECTION

**SECTION 31 66 13**  
**CEMENT-TREATED AGGREGATE (CTA) PIERS AND RIGID INCLUSION FOUNDATION SYSTEMS**

**PART 1 – GENERAL**

1.1 STIPULATIONS

- A. The specifications sections “General Conditions to the Construction Contract”, “Special Conditions” and “Division 01 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.1 DESCRIPTION

- A. Work shall consist of designing, furnishing and installing Cement-treated Aggregate (CTA) Piers and/or Rigid Inclusions to the lines and grades designated on the project drawings and as specified herein. The piers shall be constructed by either auguring a shaft or driving a hollow mandrel to the design depth and vertically ramming lifts of aggregate/cement mixture using a tamper head and high-energy impact densification equipment to create the CTA Piers or auguring a shaft using a displacement method where grout is injected through the auger shaft as the auger is withdrawn, in such a way to exert positive upward grout pressure on the earth filled auger flights, as well as a positive lateral pressure on the soil surrounding the grout filled hole to create Rigid Inclusions. The CTA Piers and/or Rigid Inclusions shall be in a columnar-type configuration and shall be used to produce an intermediate foundation system.

1.2 WORK INCLUDED

- A. Provision of all equipment, material, labor, and supervision to design and install CTA Piers and/or Rigid Inclusions. Design shall conform to requirements of the Geotechnical Engineering Report and this specification.
- B. CTA Piers and/or Rigid Inclusion design and installation shall adhere to all methods and standards described in this Specification.
- C. Drawings and General Provisions of the Contract, including General and Supplemental Conditions, and Division 1 Specifications, apply to the work in this specification.

1.3 SITE CONDITIONS

- A. The Installer shall examine the areas and conditions under which the CTA Piers and/or Rigid Inclusions are to be installed and notify the general contractor and/or architect/engineer, in writing, of conditions detrimental to the proper and timely completion of the work.
- B. CTA Piers and/or Rigid Inclusion design and installation shall adhere to all methods and standards described in this Specification.

1.4 INSTALLERS

- A. The CTA Piers and/or Rigid Inclusion Installer (the Installer) shall be approved by the Owner’s Engineer.
- B. Installers of CTA Piers and/or Rigid Inclusion foundation systems shall have a minimum of 5 years of experience with the installation of CTA Piers and/or Rigid Inclusion systems and shall have completed at least 50 projects.
- C. Without exception, no installer will be accepted unless approved by Owner’s Engineer.

- D. Installers to submit evidence of successful installation of CTA Piers and/or Rigid Inclusions under similar job and subsurface conditions, including, at a minimum, experience installing CTA Piers and/or Rigid Inclusions on at least 5 projects in similar karst geology, and resumes for the CTA Pier and/or Rigid Inclusion Designer of Record (Designer) and job supervisor who shall each have a minimum of five (5) years of method specific experience.

## 1.5 REFERENCE STANDARDS

### A. Design

1. "Control of Settlement and Uplift of Structures Using Short Aggregate Piers," by Evert C. Lawton (Assoc. Prof., Dept. of Civil Eng., Univ. of Utah), Nathaniel S. Fox (President, Geopier Foundation Co., Inc.), and Richard L. Handy (Distinguished Prof. Emeritus, Iowa State Univ., Dept. of Civil Eng.), reprinted from IN-SITU DEEP SOIL IMPROVEMENT, Proceedings of sessions sponsored by the Geotechnical Engineering Division/ASCE in conjunction with the ASCE National Convention held October 9-13, 1994, Atlanta, Georgia.
2. "Settlement of Structures Supported on Marginal or Inadequate Soils Stiffened with Short Aggregate Piers," by Evert C. Lawton and Nathaniel S. Fox. Geotechnical Special Publication No. 40: Vertical and Horizontal Deformations of Foundations and Embankments, ASCE, 2, 962-974.
3. "Bearing Capacity and Settlement of Pile Foundations", by George Geoffrey Meyerhof, ASCE Journal of the Geotechnical Engineering Division, Vol. 102, No. 3 March 1976, pp.195-228.

### B. Load Testing

1. ASTM D1143 - Pile Load Test Procedures
2. ASTM D1194 - Spread Footing Load Test
3. ASTM D7383-08 – Axial Compressive Force Pulse (Rapid) testing of Deep Foundations (Statnamic Testing)

### C. Materials and Inspection

1. ASTM D1241 - Aggregate Quality
2. ASTM D422 - Gradation of Soils
3. ASTM C31 Standard Practice for Making and Curing Cement Test Specimens in the field
4. ASTM C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

## 1.6 CERTIFICATIONS AND SUBMITTALS

- A. Design Calculations - The Installer shall submit design calculations and construction drawings prepared by the CTA Piers and/or Rigid Inclusion Designer of Record (Designer) for review and approval by the Owner or Owner's Engineer. All plans shall be sealed by a Professional Engineer in the Commonwealth of Pennsylvania.
- B. Design Drawings – The Installer shall submit design drawings referenced to the structural plans, including a numbering system capable of identifying each individual CTA Pier or Rigid Inclusion.
- C. Load Test Reports – A load test should be performed on a non-production CTA Pier and/or Rigid Inclusion to verify design assumptions. The Installer shall submit a dimensioned sketch of the loading arrangement, including sizes of primary members, and data on testing and measuring equipment, including required jack and/or gauge calibration. The submittal shall include load testing methods and loading schedule and duration. The Installer shall furnish to the General Contractor installation records, test data, analysis of the test data and verification of the design parameter values based on the load test results. The report shall be prepared under direction of a Registered Professional Engineer. c. Load test reports shall be prepared in accordance with the most current version of the applicable ASTM and/or governing Code Standards.



- D. Description of the CTA Pier and/or Rigid Inclusion drilling, tamping, and/or pumping equipment to be utilized and for Rigid Inclusions, a description of any Automated Monitoring Equipment (AME) proposed to measure and record drilling rate, depth and pressure; and grouting volume and pressures.
- E. Proposed pile grout design mix and descriptions of materials to be used. These shall be in sufficient detail to indicate their compliance with the specifications and either (1) laboratory tests of trial mixes made with the proposed mix, or (2) laboratory tests of the proposed mix used on previous projects.
- F. Daily Pier Progress Reports – The Installer shall furnish complete and accurate records of CTA Piers and/or Rigid Inclusion installation to the General Contractor. Such records shall at a minimum, include: project name and number, CTA Pier and/or Rigid Inclusion location, as-built diameter, as-built tip elevation, drilling ground surface elevation, total and incremental volume of grout, aggregate, and/or cement placed, and any unusual occurrences during the CTA Piers and/or Rigid Inclusion installation, etc. The records shall indicate Records shall be kept for each CTA Pier and/or Rigid Inclusion installed.
  - 1. Submit copies of the installation record of each pile not later than the morning of the next working day after the pile was installed. “Problem” CTA Piers and/or Rigid Inclusions should be reported as soon as the problem is detected so that the situation can be immediately rectified and re-drilling, re-grouting, and/or replacement CTA Piers and/or Rigid Inclusion can be addressed.

#### 1.7 BASELINE GEOTECHNICAL, CIVIL, AND STRUCTURAL ENGINEERING INFORMATION

- A. The design of CTA Piers and/or Rigid Inclusions shall be based on the soils data provided in the project geotechnical report.
- B. The structural engineer shall provide actual dead and live loads for each footing location and bearing pressure diagrams for retaining wall and shear wall footings to be able to calculate estimated total and differential settlement values. A loading diagram shall be provided for any footings subject to a moment. Any net uplift loads shall be highlighted so uplift anchors can be provided.
- C. Civil Site design drawings shall highlight all existing and future utilities and new fill that will be placed on site. A construction sequence shall be provided that highlights when abandoned

### **PART 2 – MATERIALS**

#### 2.1 AGGREGATE

- A. Aggregate used in CTA Piers shall be pre-approved by the Designer and shall demonstrate suitable performance during load testing.
- B. Cement used in CTA Piers shall meet the requirements for Type I or Type II Portland cement per ASTM C150.
- C. Fine Aggregate: Sand utilized as fine aggregate shall meet the requirements of ASTM C33.

#### 2.2 GROUT

- A. Portland Cement in Rigid Inclusions shall conform to current ASTM Standards, Designation C-150.
- B. Mineral admixtures, if used, shall be flyash or natural pozzolan, which possesses the property of combining with the lime liberated during the process of hydration of Portland Cement to form compounds containing cementitious properties. The material shall conform to ASTM C-618, Class C or Class F.

- C. Chemical Admixtures supplied by the ready-mix producer shall conform to ASTM C494 and might consist of, but not limited to, water reducers and/or set retarders. Grout fluidifier, when utilized, shall conform to ASTM C937.
- D. The grout mixed used in production Rigid Inclusions must be the same and the grout mixed used in the approved load test Rigid Inclusion.
- E. The components shall be proportioned and mixed to produce a grout capable of maintaining the solids in suspension and being efficiently pumped. These materials shall be proportioned to produce a hardened grout which will achieve the design unconfined compressive strength within 28 days specified on the approved Shop Drawing.
- F. The grout mix shall be sampled and tested by making a set of six (6) 2-in. cubes or 6-in. cylinder for each 50-cy of grout placed, or at least one set for each day during which Rigid Inclusions are placed. Two cubes or cylinders shall be tested at 7 days, two cubes or cylinders tested at 28 days, and two cubes or cylinders held in reserve. Cubes or cylinders shall be cured and tested in accordance with ASTM C109. Cube or cylinder specimens shall be restrained from expansion as described in ASTM C942.
- G. Adding water to grout on-site. It is sometimes necessary to add water to the grout on-site to provide a consistent grout mixture prior to pumping. The amount of water that may be added to provide both consistent and adequate flow characteristics must not compromise the specified grout strength, or the water/cement ratio specified in the approved Shop Drawing.
- H. The amount of added water shall be recorded by the Testing Agency and the Inspector, and samples taken for compression testing.

## 2.3 WATER

- A. Water shall be potable, fresh, clean, and free of sewage, oil, acid, alkali, salts, organic matter, suspended solids, or other materials that may be detrimental to the grout quality. Recycled/reclaimed water may be used provided its inclusion and associated temperature does not adversely impact the design compressive strength of the mix.

## PART 3 – DESIGN REQUIREMENTS

### 3.1 DESIGN

- A. The design of the CTA Piers and/or Rigid Inclusions shall be based on the service load contact pressure and the allowable total and differential settlement criteria as indicated by the structural drawings for support by the CTA Piers and/or Rigid Inclusions. The CTA Piers and/or Rigid Inclusions shall be designed in accordance with generally-accepted engineering practice and the methods described in Section 1 of these Specifications. The design life of the structure shall be 50 years.
- B. The design shall meet the following criteria.
  1. Maximum Allowable Bearing Pressure for Footings supported by CTA Pier or Rigid Inclusion Reinforced Soils 5,000 psf
  2. Estimated Total Long-Term Settlement  $\leq$  1/2-inch
  3. Estimated Long-Term Differential Settlement  $\leq$  1/4-inch
- C. CTA Piers and/or Rigid Inclusions shall have a minimum installed length of 4-ft.
- D. The CTA Piers and/or Rigid Inclusions shall be designed and installed to completely penetrate existing Man-placed Fill where encountered.
- E. The Designer should confirm that footing design provided in the structural foundation plan is compatible with their proposed system to limit the risk of punching due to the high stress concentration imposed by the CTA Pier and/or Rigid Inclusion.

- F. Rigid Inclusion Pier Design Capacity – the capacity of individual rigid inclusions shall be the lesser of the geotechnical and structural capacity as defined below:
  - 1. Geotechnical Requirements – The geotechnical capacity shall be calculated using Meyerhof bearing capacity method. Shaft capacity shall not be considered in fill materials. Shaft resistance may be considered when the pier extends a minimum 5 feet into a competent soils stratum. For piers where the shaft extends a minimum of five feet into the bearing stratum or extends through multiple soils strata below an unsuitable layer, a unit friction value should be computed for each layer and the total shaft resistance should be taken as the summation of the individual layers.
  - 2. Structural Requirements – The structural capacity of the pier used for design shall not exceed  $0.3 \times f'c$ , where  $f'c$  equals the 28 day compressive strength of the cement/aggregate mixture as sampled on site and confirmed by compressive strength testing per ASTM C39.
- G. Load Transfer Platform (LTP) Design - A LTP must be used to create a shear break between the CTA Pier and/or Rigid Inclusion. Calculations shall be provided to determine the thickness and lateral extent needed for an LTP to transfer the load from the footing to the CTA Pier and/or Rigid Inclusion.
- H. The CTA Piers and/or Rigid Inclusions shall be designed using a stiffness modulus to be verified by the results of the load test described in Section 5.02 of these specifications.

### 3.2 DESIGN SUBMITTAL

- A. The Installer shall submit detailed design calculations and Shop Drawings, for approval at least 2 week(s) prior to the beginning of construction. A detailed explanation of the design parameters for settlement calculations shall be included in the Design Submittal. Additionally, the quality control test program for the CTA Pier and/or Rigid Inclusion Pier system, meeting these design requirements, shall be submitted. All computer-generated calculations and drawings shall be prepared and sealed by a Professional Engineer, licensed in the Commonwealth of Pennsylvania. Submittals will be submitted electronically only unless otherwise required by specific submittal instructions.

## PART 4 – EXECUTION

### 4.1 APPROVED INSTALLATION PROCEDURES

- A. Because of the karst geology, each CTA Pier and/or Rigid Inclusion location should be air tracked to investigate the presence of mudseams. Where mudseams are encountered, they must be grouted prior to installation of the CTA pier and/or Rigid Inclusion.
- B. The installation method used for CTA Pier and/or Rigid Inclusion construction shall be that as used in the construction of the successful modulus test.
- C. Dense Man-placed Fill is expected and the equipment should be capable of installing the ground improvement system in very dense soils where encountered.
- D. Installer shall use machines or combinations of machines and equipment that are in good working condition and are safe to operate.
- E. Installer shall inspect the site prior to the start of operations to verify the ground improvement can be constructed safely using the proposed equipment prior to installation of CTA Piers and/or Rigid Inclusions.
- F. CTA Piers
  - 1. CTA Pier systems shall be pre-augered using mechanical drilling or excavation equipment.

2. If cave-ins exceeding 10 percent of the lift volume occur during excavation such that the sidewalls of the hole are deemed to be unstable, steel casing shall be used to stabilize the shaft or a Rigid Inclusion system may be used.
3. Aggregate shall be placed in the augered shaft in lift thicknesses as provided in the approved Shop Drawings, and successfully used in the load test. by the
4. A specially-designed beveled tamper and high-energy impact densification apparatus shall be employed to densify lifts of aggregate during installation. The apparatus shall apply direct downward impact energy to each lift of aggregate. Compaction equipment that induces horizontal vibratory energy (such as Vibroflot equipment) is not permitted.
5. CTA materials that are mixed or delivered on site shall mixed dry and shall all be used within 8 hours of mixing.
6. At a minimum, 2-ft. of cement treated aggregate must be installed above the bedrock.
7. The upper 2-ft. of CTA Piers may be constructed using non-cement treated aggregate to provide the required shear break using the same means and methods provided that the CTA Pier installation procedure used is the same as constructed in a successful load test.

G. Rigid Inclusions

1. Rigid Inclusions shall be augered and the auger shall have continuous flighting from the auger head to the top of the auger without gaps or other breaks. The auger flighting shall be uniform in diameter throughout its length.
2. The hole through which the grout is pumped during the placement of the Rigid Inclusion shall be located at the bottom of the auger head.
3. The grout pump shall be provided with a pressure gauge in clear view of the equipment operator.
4. Grout shall be pumped at a rate that creates a continuous columnar support element and prevents "necking" of the Rigid Inclusions ensuring that the design diameter of the Rigid Inclusion is achieved.
5. Installer should confirm that grout is present at the ground surface immediately following installation before cutoff operation is made.

4.2 PLAN LOCATION AND ELEVATION OF CTA PIERS AND/OR RIGID INCLUSIONS

- A. The as-built center of each CTA Pier and/or Rigid Inclusion shall be within 6 inches of the locations indicated on the approved Shop Drawings and shall be fully within the footprint of each spread footing. CTA Piers and/or Rigid Inclusion installed outside of the above tolerances and deemed not acceptable shall be rebuilt at no additional expense to the Owner.

4.3 REJECTED CTA PIERS AND/OR RIGID INCLUSION

- A. Pier elements installed beyond the maximum allowable tolerances shall be abandoned and replaced with new piers, unless the Designer and the Geotechnical Engineer approves the condition or provides other remedial measures. All material and labor required to replace rejected piers shall be provided at no additional cost to the Owner, unless the cause of rejection is due to an obstruction or mislocation.

**PART 5 – QUALITY CONTROL**

5.1 QUALITY CONTROL TECHNICIAN

- A. The Installer shall have a full-time, on-site Quality Control (QC) Technician to verify and report all installation procedures. The Installer shall immediately report any unusual conditions encountered during installation to the Geotechnical Engineer, the General Contractor, and to the Testing Agency.

5.2 LOAD TESTING

- A. Prior to the start of CTA Pier or Rigid Inclusion installation, a minimum of one (1) load test shall be provided at a location selected by the Owner's Geotechnical Engineer, to confirm the design and for establishing quality control procedures. The Installer shall furnish a description of installation equipment, installation records, complete test data and analysis of the test data, including design parameter values for each test CTA Pier or Rigid Inclusion. The report shall be prepared under the supervision of a registered Professional Engineer licensed in the Commonwealth of Pennsylvania and experienced in this type of geotechnical design and installation. Shop drawings on proposed test set up shall be submitted for approval prior to the tests.
- B. Load test CTAs Piers and/or Rigid Inclusions may not be part of the finished work.
- C. Testing shall be performed to a stress level of 200 percent of the axial compressive capacity identified on the approved Shop Drawings. The load test schedule shall be submitted for approval.
- D. Each load increment shall be held for the minimum duration shown. For each load increment the deflection of the top plate and the bottom plate shall be measured. The top plate shall be located on top of the pier or on top of concrete cast on top of the CTA Pier and/or Rigid Inclusion. The bottom plate shall be located within 1 foot of the bottom design depth of the pier. In lieu of a bottom plate, a strain gauge may be used. Except for the load increment representing approximately 125 percent of the design capacity, if the rate of the pier deflection exceeds 0.01 inches per hour, the load shall be held in 15-minute increments until the rate of the pier deflection is less than 0.01 inches per hour (0.0025 inches per 15 minutes), or the maximum duration is reached. The load increment that represents approximately 125 percent of the design maximum stress on the pier shall be held for a minimum of 1 hour, a maximum of 4 hours and until the rate of deflection reduces to 0.01 inch per hour or less.
- E. Test pier deflections of each plate shall be measured using a minimum of two dial gauges graduated to 0.00 1 inches. Dial gauges shall be anchored to the loading jack base, with gauge plungers set on reference beams anchored at least two diameters from the pier.
- F. A seating load equal to 5 percent of the total load shall be applied to the loaded steel plate pier prior to application of load increments and prior to measurement of deflections to compensate for surficial disturbance.
- G. Load test acceptance criteria shall be no more than 0.5-inch settlement at the CTA Pier and/or Rigid Inclusion design load at the test location and settlement should not exceed the Davisson Criteria for any load increment.

### 5.3 BOTTOM STABILIZATION TESTING (BSTS)

- A. If CTAs Piers are used, Bottom stabilization testing (BSTs) shall be performed by the QC Technician during the installation of the load test CTA Pier. Additional testing as required by the Designer shall be performed on selected production CTAs Piers to compare results with the load test CTA Pier. At a minimum, ten percent (10%) of the CTAs Piers installed each day should be tested.

## PART 6 – QUALITY ASSURANCE

### 6.1 INDEPENDENT ENGINEERING TESTING AGENCY (OWNER'S QUALITY ASSURANCE)

- A. The Installer shall provide full-time Quality Assurance (QA) monitoring of CTA Pier and/or Rigid Inclusion construction activities. The Owner or General Contractor is responsible for retaining an independent engineering testing firm to provide Quality Assurance services.

- B. The QA Inspector will observe the CTA Pier and/or Rigid Inclusion installation operation and report the observation results. Report records shall include the information identified in Section 1.06.A.
- C. Grout, if used, shall be sampled and tested to verify the unconfined compressive strength of the grout. The number of samples and schedule of tests shall be as outlined in Section 2.02.1. The Testing Agency representative shall have at a minimum ACI Level I certification. The testing laboratory shall have a current AASHTO certification.
- D. The Installer shall cooperate with the QA Inspector in the performance of their work. The presence of the QA Inspector shall in no way relieve the Installer of Installer's obligation to perform the CTA Pier and/or Rigid Inclusion installation in accordance with the Contract Drawings and these Specifications.

## 6.2 RESPONSIBILITIES OF INDEPENDENT ENGINEERING TESTING AGENCY

- A. The Testing Agency shall monitor the load test CTA Pier and/or Rigid Inclusion installation and testing. The Installer shall provide and install all dial indicators and other measuring devices.
- B. The Testing Agency shall monitor the installation of CTA Piers and/or Rigid Inclusions to verify that the production installation practices are similar to those used during the installation of the modulus test elements.
- C. The Testing Agency shall report any discrepancies to the Installer and General Contractor immediately.
- D. The Testing Agency shall observe the excavation, compaction and placement of the foundations as described in Section 7.05.

## PART 7 – RESPONSIBILITIES OF THE GENERAL CONTRACTOR

### 7.1 SITE PREPARATION AND PROTECTION

- A. The General Contractor shall locate and protect underground and aboveground utilities and other structures from damage during installation of the CTA Piers and/or Rigid Inclusions.
- B. Ground elevations and bottom of footing elevations shall be provided to the Installer in sufficient detail to estimate installation depth elevations to within 3 inches.
- C. The General Contractor will provide site access to the Installer, after earthwork in the area has been completed. A working surface shall be established and maintained by the General Contractor to provide wet weather protection of the subgrade and to provide access for safe and efficient operation of the CTA Piers and/or Rigid Inclusions installation.
- D. Prior to, during and following CTA Piers and/or Rigid Inclusions installation, the General Contractor shall provide positive drainage to protect the site from wet weather and surface ponding of water.
- E. For Rigid Inclusions a minimum of 6 inches of aggregate or granular soil shall separate the rigid inclusion from the bottom of footing. The thickness and type of granular soil shall be as specified in the approved Shop Drawings and shall be the responsibility of the general contractor for placement.

## 7.2 EXCAVATIONS OF OBSTRUCTIONS

- A. Should any obstruction be encountered during CTA Piers and/or Rigid Inclusions installation, the General Contractor shall be responsible for promptly removing such obstruction or the CTA Pier and/or Rigid Inclusion shall be relocated or abandoned. Obstructions include, but are not limited to, boulders, timbers, concrete, bricks, utility lines, etc., which shall prevent placing the piers to the required depth or shall cause the pier to drift from the required location.
- B. Weathered rock layers shall not be deemed obstructions, and piers may be terminated short of design lengths on such materials with approval of the Geotechnical Engineer.

## 7.3 UTILITY EXCAVATIONS

- A. The General Contractor shall coordinate all excavations made subsequent to CTA Pier and/or Rigid Inclusion installations so that excavations do not encroach on the piers as shown in the CTA Piers and/or Rigid Inclusions approved Shop Drawings. Protection of completed CTA Piers and/or Rigid Inclusions is the responsibility of the General Contractor. In the event that utility excavations are required in close proximity to the installed CTA Piers and/or Rigid Inclusions, the General Contractor shall contact the Designer immediately to develop construction solutions to minimize impacts on the installed CTA Piers and/or Rigid Inclusions.

## 7.4 FOOTING BOTTOMS

- A. Excavation and surface compaction of all footings shall be the responsibility of the General Contractor.
- B. Foundation excavations to expose the tops of CTA Piers and/or Rigid Inclusions shall be made in a workman-like manner, and shall be protected until concrete placement, with procedures and equipment best suited to avoid exposure to water and prevent softening of the matrix soil between and around the CTA Piers and/or Rigid Inclusions before placement of the LTP.
- C. In addition to any requirements provided in the approved Shop Drawings, all excavations for footing bottoms supported by CTA Piers and/or Rigid Inclusions shall be prepared in the following manner by the General Contractor:
  - 1. Limit over-excavation below the bottom of the LTP to 3-inches (including disturbance from the teeth of the excavation equipment).
  - 2. If CTA Piers are installed, compaction of surface soil and top of CTA Piers shall be prepared using a motorized impact compactor ("Wacker Packer," "Jumping Jack," or similar) prior to installation of the LTP. Sled-type tamping devices shall only be used in granular soils and when approved by the designer.
  - 3. If Rigid Inclusions are installed the Contractor should use means and methods to ensure that the tops of the Rigid inclusions are not "snapped off" and that the top of the Rigid Inclusion is level before placement of the LTP. In no case should the Rigid Inclusion have an angled surface.
- D. The following criteria shall be documented by the QC firm:
  - 1. That water (which may soften the unconfined matrix soil between and around the CTA Piers and/or Rigid Inclusions and may have detrimental effects on the supporting capability of the reinforced subgrade) has not been allowed to pond in the footing excavation at any time.
  - 2. That all CTA Piers and/or Rigid Inclusions designed for each footing have been exposed in the footing excavation.
  - 3. That immediately before placement of the LTP, the tops of CTA Piers and/or Rigid Inclusions exposed in each footing excavation have been inspected and recompacted (in the case of the CTA Pier) as necessary with mechanical compaction equipment.

**END OF SECTION**

SECTION 320519  
GEOTEXTILES FOR EXTERIOR IMPROVEMENTS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 DESCRIPTION

- A. Contractor shall furnish and install geotextile for the class specified.

1.3 QUALITY ASSURANCE

- A. Install geotextile in accordance with Sections 212 and 735, PENNDOT Specifications, Publication 408.

1.4 SUBMITTALS

- A. Manufacturer's product data and installation instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Geotextile: PENNDOT Class 2, Type A for erosion control.
- B. Securing Pins: Steel, 18 inches long by 3/16 inches in diameter, pointed at one end, and with a 1 ½ inch diameter washer head at the other end.
- C. Coarse Aggregate: AASHTO #57.

PART 3- EXECUTION

3.1 INSTALLATION

- A. Install to line and grade as shown on drawings.
- B. Remove vegetation, large stones, and other debris from the area to be protected and grade the surface to a smooth condition. Excavate areas of unacceptable material and replace with acceptable compacted material as directed.
- C. Place the fabric in the prepared area in a loose and unstretched condition to minimize shifting, puncturing, or tearing the fabric.
- D. Join adjacent edges and ends with a folded seam and sew using a single lock-type stitch seam or a double chain type stitch seam equivalent in strength to the fabric tensile strength. Sewing may be done on-site or by the manufacturer.
- E. Overlap only if permitted and then as directed. Provide a minimum overlap of 1 foot. For underwater placement, overlap a minimum of 3 feet. Offset adjacent roll ends a minimum of 5 feet when lapped.
- F. Fabric laying and overlapping direction:
  - 1. Fabric Laying Direction: Parallel with slope direction.
  - 2. Overlap Direction: Upslope over downslope.
- G. Anchor the securing pins along sewn seams or overlaps every 2 feet. Also place securing pins on a maximum 6 foot grid on the unsewn or unlapped portions of the fabric. In areas where the slope is less than 6:1, no securing pins are to be used.



- H. Cover the fabric with the covering material as soon as possible, so the fabric is not exposed for more than 4 weeks. Prevent slippage of the cover material on the fabric.
- I. Do not drop rocks 2 feet or larger in dimension directly on the fabric from a height greater than 1 foot. Do not allow the rock placement procedure to puncture or damage the fabric. A minimum 6-inch layer of bedding stone will be placed over the fabric.

END OF SECTION

SECTION 321123  
AGGREGATE BASE COURSES

PART 1- GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 DESCRIPTION

- A. See current Pennsylvania Department of Transportation Form 408 Specifications, Section 350, Subbase, Subsection 350.1.

PART 2- PRODUCTS

2.1 MATERIAL

- A. See current Pennsylvania Department of Transportation Form 408 Specifications, Section 350, Subbase, Subsection 350.2.

PART 3- EXECUTION

3.1 CONSTRUCTION

- A. See current Pennsylvania Department of Transportation Form 408 Specifications, Section 350, Subbase, Subsection 350.3.

END OF SECTION

SECTION 321216  
ASPHALT PAVING

PART 1- GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 DESCRIPTION

- A. Pennsylvania Department of Transportation Specifications Publication 408 Section 309-Superpave Asphalt Mixture Design, Standard Construction, HMA Base Course is hereby incorporated by reference into the contract documents, and shall be used.
- B. Pennsylvania Department of Transportation Specifications Publication 408 Section 409 – Superpave – Mixture Design, Standard and RPS Construction of Plant – Mixed HMA Courses is hereby incorporated by reference into the contract documents, and shall be used for any item of work not otherwise specified by separate section number.
- C. References to department or engineer in PENNDOT Publication 408 shall mean engineer or owner as context requires and defined in the general conditions.
- D. PENNDOT Publication 408, may be obtained from:  
Penn DOT Publication Sales  
Forms & Publication Warehouse  
Building 33, Harrisburg International Airport  
Middletown, Pennsylvania 17057

PART 2- PRODUCTS

2.1 MATERIALS

- A. Materials as required in PENNDOT Publication 408 unless noted otherwise.
- B. All materials (pipe, manholes, casing, etc.) must be stored off of state right-of-way and out of roadway clear zones.

PART 3- EXECUTION

3.1 CONSTRUCTION

- A. Installation as required by PENNDOT Publication 408.

END OF SECTION

SECTION 321218  
PAVING RESTORATION

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 QUALITY ASSURANCE

- A. Requirements of Pennsylvania Department of Transportation:
  - 1. Operation within state highway right-of-way: Conform to Pennsylvania Department of Transportation Regulations, 67 Pennsylvania Code, Chapter 459.

1.3 JOB CONDITIONS

- A. Existing conditions: Do not place stone on soft, muddy, or frozen areas, nor until all irregularities in roadway or shoulder have been corrected.

1.4 SUBMITTALS

- A. Certificates: Delivery tickets.
- B. Shop Drawings showing mix design, naming applicable State and Municipal roads.

PART 2- PRODUCTS

2.1 MATERIALS

- A. Coarse aggregate for shoulders and subbase: PennDOT No. 2A aggregate.
- B. Superpave asphalt mixture design, HMA base course, pg 64-22, 3 to 10 million esals, 25mm mix: PennDOT Publication 408.
- C. Superpave asphalt mixture design, HMA binder course, pg 64-22, 3 to 10 million esals, 12.5mm mix: PennDOT Publication 408.
- D. Superpave asphalt mixture design, HMA wearing course, pg 64-22, 3 to 10 million esals, 9.5mm mix, SRL-H: PennDOT Publication 408.
- E. Joint sealer: Asphalt cement, Class AC-20.
- F. Concrete:
  - 1. State highway repair: PennDOT Class H.E.S. 3750PSI.
  - 2. Other locations: PennDOT Class A, 3300PSI.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Saw cut openings in pavement along neat lines.
- B. Paint exposed edges with joint sealer before paving is placed.
- C. Surface seal final joints with joint sealer.

3.2 STATE ROADWAYS

- A. Install as required by PennDOT Regulations, 67 Pennsylvania Code Chapter 459.
- B. Place in accordance with PennDOT Publication 408 Specifications.
- C. Restore pavement in accordance with Section 459.8(h) PennDOT Chapter 459 Regs.

- D. Temporary pavement must be placed immediately after trench is backfilled and before the contractor leaves the site at the end of the day.

### 3.3 MUNICIPAL ROADWAYS

- A. Temporary restoration:
  - 1. Place and compact PennDOT No. 2A aggregate on backfilled area level with roadway surface.
    - a. Maintain aggregate level with surface for 60 to 180 days before final repair is made.
- B. Permanent paving repair:
  - 1. Remove temporary restoration measures.
  - 2. Materials and depths: As shown on drawings.
  - 3. Place in accordance with PennDOT Publication 408 Specifications.

### 3.4 DRIVEWAYS AND PAVED AREAS

- A. Bituminous surface:
  - 1. Restore surface in kind or with minimum 2 ½" Superpave asphalt mixture design, HMA base course, pg 64-22, 3 to 10 million esals, 25mm mix and 1 ½" Superpave asphalt mixture design, HMA wearing course, pg 64-22, 3 to 10 million esals, 9.5mm mix over compacted PennDOT No. 2RC aggregate.
  - 2. Place in accordance with PennDOT Publication 408 Specifications.
- B. Concrete surface:
  - 1. Restore surface in kind or with 8" concrete reinforced with 6x6x10 wire mesh over compacted PennDOT No. 2A aggregate.
- C. Brick surface:
  - 1. Restore with like bricks on a 4" wet sand bed.

### 3.5 SIDEWALKS AND CURBS

- A. Reconstruct curbs and sidewalks a minimum of one foot on each side of damaged area. Install ¾" expansion joint at end of days work or where new sidewalk abuts existing sidewalk.
- B. Restore concrete surfaces with 4" concrete on bed of compacted PennDOT No. 2A aggregate.
- C. Restore bituminous and brick surfaces to original thickness and/or pattern.
- D. Seal joints as per PennDOT Pub 408, Section 676.

### 3.6 UNPAVED AREAS

- A. Restore all disturbed properties as nearly as practical to their original condition.

END OF SECTION

SECTION 321313  
CONCRETE PAVING

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUBMITTALS

- A. Quality Control Plan Structural Concrete.
- B. Test reports of concrete compression, air and slump tests.
- C. Delivery tickets.

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Vehicles for transporting concrete shall be capable of maintaining a thoroughly mixed and uniform concrete and have the capabilities to discharge the concrete without segregation, when loaded to their rated capacity.
- B. Maximum time from mixing to discharge shall be 1-1/2 hours.
- C. When hot weather or other conditions contribute to quick stiffening or when the temperature of the concrete is 85 degrees F or above, the time between completion of mixing and discharge shall not exceed one hour.
- D. It is permissible to stop agitating the concrete for periods not to exceed 30 consecutive minutes each.
- E. The concrete shall be agitated for at least 20 revolutions at end of any non-agitated period.
- F. The interval between placing succeeding batches shall be 30 minutes maximum.
- G. Interior surfaces of conveying equipment and appurtenances shall be kept free from hardened concrete, debris, water and other deleterious materials.

1.4 CONCRETE PLACEMENT

- A. Concrete shall not be placed during rain, sleet or snow unless protection is provided.
- B. Allowable concrete temperature:
  - 1. Cold weather: minimum 50 degrees F, maximum 80 degrees F.
  - 2. Hot weather: maximum 90 degrees F.
- C. 40 degrees F. is the minimum air temperature for placing concrete.
- D. 40 degrees F. is the minimum air temperature for placing joint sealer.
- E. Air temperatures shall be taken in the shade.
- F. Comply with ACI 306 when placing concrete in cold weather to protect concrete work from physical damage and reduce strength which would be caused by frost, freezing actions or low temperatures.
- G. Hot weather placing:
  - 1. Use chilled mixing water or chopped ice to control temperature.
    - a. Calculate water equivalent of ice to total amount of water.
  - 2. Cover reinforcing steel with water-soaked burlap if steel becomes too hot.
    - a. Steel temperature shall not exceed ambient air temperature immediately prior to placement of concrete.
  - 3. Wet forms thoroughly prior to placement of concrete.
  - 4. Use set-control admixtures in mix.

1.5 QUALITY ASSURANCE

- A. Flatwork true to plane 1/4 inch to 10 feet.

## PART 2- PRODUCTS

### 2.1 MATERIALS

- A. Ready mixed cement concrete shall be 4,000 psi cement concrete, unless otherwise noted.
  - 1. Cement: Type Ia, ASTM C150.
    - a. Approximate amount of entrapped air: 6.0 percent within a tolerance of  $\pm 1.5\%$
- B. Curing material shall be liquid membrane-forming curing compound, Type I, clear or translucent, and shall contain a fugitive dye, ASSHTO M 148.
- C. Expansion joint filler shall be  $\frac{3}{4}$ -inch fiber type, ASTM D 1751.

### 2.2 CEMENT-CONCRETE MIXES

- A. Mix requirements of the PENNDOT 408 Specifications shall be followed.
- B. Maintain material quantities within allowable tolerances of the PENNDOT 408 Specifications.
- C. Prepare job-mix formula to meet test criteria of the PENNDOT 408 Specifications.

### 2.3 EQUIPMENT

- A. Horizontal-axis or inclined axis revolving-drum agitators.

## PART 3- EXECUTION

### 3.1 PREPARATION

- A. Form foundation for the bed below and parallel with the bottom of the slab of the footing.
- B. Compact foundation.
- C. Spread aggregate as required, on prepared foundation to form a compacted bed.
- D. Forms shall be cleaned and oiled before concrete is placed against them.

### 3.2 INSPECTION

- A. Verify that excavations and form work are completed and that ice and excess water have been removed.
- B. Verify that reinforcement is secured.
- C. Check that expansion joint material, anchors, and other embedded items are secured in position.

### 3.3 PLACEMENT CONCRETE

- A. Convey concrete from mixer to final position in a manner to prevent separation or loss of material.
- B. Maximum height of concrete free fall shall be four feet.
- C. Regulate rate of placement so the concrete remains plastic and flows into position.
- D. Place concrete in a continuous operation until a section is completed.
- E. Place concrete in horizontal layers so such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or plans of weakness within the section.
  - 1. Maximum thickness:
    - a. Vibrated: 18 inches.
    - b. Spaded: 8 inches.
- F. Screed concrete which is to receive other construction to proper level to avoid excessive skimming and grouting.

### 3.4 COMPACTING CONCRETE

- A. Compact concrete immediately after placing by hand-spading, rodding, tamping, or vibrating in accordance with ACI 309.

### 3.5 FINISHING

- A. Strike and level concrete.
- B. Surface shall not be worked until it is ready for floating.
- C. Begin floating upon disappearance of water sheen and when the concrete has sufficiently stiffened.
- D. After floating, remove all excess water and mortar from the surface with a straightedge.
- E. Test concrete surface for trueness with a ten-foot straightedge, while the concrete is still plastic.
  - 1. Fill depressions with freshly mixed concrete, strike off, and refinish.
  - 2. Cut down and refinish high areas.
- F. Slope surface to drains where required.
- G. Immediately after leveling, surface shall be refloated to a uniform, smooth granular texture.
- H. Trowel finish slab surface.
- I. Immediately after trowel finishing, slightly roughen concrete surface by brooming in direction perpendicular to main traffic route using a fiber bristle broom.

### 3.6 JOINTS

- A. Install construction joints where required:
  - 1. Slabs on grade: Locate joints in a manner to divide slab into areas not in excess of 600 square feet with one dimension being not greater than 120 percent of other dimension.
    - a. Width: 1/4 inches.
    - b. Depth: 1-1/2 inches.
  - 2. Continue reinforcement across construction joints.
- B. Expansion joints in slabs on grade:
  - 1. Expansion joints shall be located at points of contact between slab and vertical surfaces.
  - 2. Expansion joint material shall be sized to conform to cross sectional area of abutting surface.
- C. Control joints in slabs on grade:
  - 1. Control joints shall be located to form panels or patterns.
  - 2. Forming control joints:
    - a. Saw cut control joints after concrete has sufficiently hardened and before shrinkage cracking occurs.
    - b. Insert pre-molded hard board or fiber board strip into fresh concrete until top surface of strip is flush with slab surface.
      - 1. After curing for at least seven days, remove inserts and clean loose debris from grooves.
    - c. Width: 1/4 inches.
    - d. Depth: 1/4 slab depth.
  - 3. Caulk joints.

### 3.7 EDGING EXTERIOR SLABS

- A. Edge all sides of slabs after final finish, but before concrete has taken initial set. Edger radius shall be 1/4 inch.

### 3.8 CURING

- A. Water cure concrete using double thickness of burlap conforming to requirements of AASHTO M 182, Class I, for burlap cloth, during interval of time after placing concrete until stripping of forms.
- B. Apply curing compound to concrete surfaces in two coats by spraying to provide a continuous, uniform membrane over all areas.



1. Maximum coverage of each application: One gallon of curing compound per 300 square feet of surface.
- C. Formed surfaces:
  1. Apply first coat immediately after stripping of forms. If the surface is dry; thoroughly wet concrete with water and apply curing compound just as surface film of water disappears.
  2. Apply the second application after the first application has set.
  3. During spray curing operations, keep any unsprayed surfaces wet with water.
- D. Compound shall be applied to unformed surfaces immediately after finishing operations have been completed and surface film of water has disappeared.
- E. Membrane curing compound shall not be applied to surfaces which are to receive additional concrete and construction joints.
- F. Contractors activities shall avoid coated surfaces for not less than 10 days.
- G. Cool weather curing and protection:
  1. When temperatures are expected to reach 50 degrees F or lower at any time during curing of concrete, or when concrete is to be placed at temperatures below 50 degrees F but not below 35 degrees F, hay or straw shall be placed over concrete not protected by forms to a minimum depth of one foot.
- H. Cold weather curing and protection:
  1. Place sufficient canvas and frames or other type of housing to completely enclose and protect fresh concrete and forms.
  2. When the air temperature is below 35 degrees F the air surrounding fresh concrete shall be kept at a temperature above 50 degrees F but not more than 80 degrees F.
  3. After concrete has been cured for the required length of time, during a 3-day period the temperature can gradually be lowered within housing to that of surrounding air temperature.
- I. Curing shall continue for seven days.

### 3.9 REMOVING FORMS

- A. Side forms are to remain in place until concrete has sufficiently hardened.
- B. After removal of forms, minor honeycombed areas shall be filled with mortar.
- C. Remove and replace areas which contain major honeycombing.

### 3.10 BACKFILLING

- A. Backfill spaces adjacent to exterior slabs after concrete has cured for a period of not less than 72 hours.
- B. Compact in four-inch layers.

### 3.11 FIELD QUALITY CONTROL

- A. Concrete slump test: Pennsylvania Test Method Number 600.
  1. Perform slump tests for each truckload. Record temperature for each test.
  2. Obtain sample from delivery to site and other trucks if required.
  3. Procedure for obtaining sample shall be in accordance with Pennsylvania Test Method Number 601.
  4. Allowable slump range is  $\pm 1.5$  inches from design slump.
  5. Concrete used for slump test shall be discarded.
- B. Concrete air test: PTM Nos. 612 and 615.
  1. Perform air tests for each sampling that contains air.
  2. Concrete used for air test shall be discarded.
- C. Compression test: Pennsylvania Test Method Number 604.
  1. Samples are to be taken and broken by the Quality Control Agent for each 50 cubic yards of concrete
  3. Procedure for obtaining sample shall be in accordance with Pennsylvania Test Method Number 601.
  4. Test cylinders at seven days and at 28 days in accordance with PENNDOT PUB 408.

5. Provide curing boxes or other equipment acceptable to the engineer, capable of maintaining the air temperature immediately adjacent to field-cured cylinders in the range of 60°F - 80°F for the first 24± 2 hours in accordance with PTM #611.
- D. Remove and discard any concrete which has segregated, is too wet, or is not of uniform consistency.
- E. Under-strength Penalty
  1. If compressive strength of in situ concrete is accepted, either without additional testing or on the basis of testing other than original cylinder compressive strength test, the Contractor shall compensate the Department for the Contractor's failure to meet specified strength requirements by paying to the Department one hundred dollars (\$100) per cubic yard for each one hundred pounds per square inch (100 psi) below the specified compressive strength. The original laboratory cured 28-day cylinder compressive strength test results only shall be used to determine the difference between specified and furnished strengths.

### 3.12 MAINTENANCE AND PROTECTION

- A. During the curing period, the concrete shall be protected from damage from mechanical impacts, water flow, loading, shock, and vibration.

END OF SECTION

## SECTION 32 13 16

### DECORATIVE CONCRETE PAVING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions" and "Division 1 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section includes colored and scored concrete paving
- B. Related Requirements:
  - 1. Section 32 13 13 "Concrete Paving" for additional concrete paving information

##### 1.3 DEFINITIONS

- A. Decorative Concrete: A cast-in-place concrete slab, integrally colored. The work is performed on the job site by trained and experienced workers.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color.
  - 1. Color charts for all concrete coloring products
  - 2. Color chart for joint sealant.
- C. Samples for Final Selection:
  - 1. For each color specified, provide three 12" x 12" or larger samples of colored concrete with specified liquid color (three colors). Provide one additional sample if initial samples are not approved.
- D. Other Action Submittals:
  - 1. Design Mixtures: For each decorative concrete paving mixture. Include alternate design mixtures when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
- E. Qualification Data:
  - 1. Concrete Contractor: Submit a list of at least five successfully completed projects of similar scale and complexity. Include project name, project address and owner contact information. Submit evidence that the project supervisor has at least five years' experience with colored and textured concrete.

##### 1.5 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Admixtures.
4. Curing compounds.
5. Joint fillers.

## 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: All Decorative Concrete work shall be installed by an experienced contractor. The contractor shall provide a qualified foreman or supervisor who has a minimum of five years' experience with colored and textured concrete, and who has successfully completed at least five textured concrete installations of high quality and similar in scope to that specified herein, and located within a 100 mile radius of the proposed project. An employer of workers trained and approved by manufacturer of decorative concrete paving systems.
- B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products with integral color and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
  1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").
- C. Testing Agency Qualifications: comply with requirements of Section 03 30 00 "Cast In Place Concrete".
- D. Source Limitations: Obtain all products for coloring and texturing concrete, and the redi-mix concrete from a single source.
- E. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.
- F. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
  1. Build mockups of full-thickness sections of decorative concrete paving to demonstrate typical joints; integral color, curing; and standard of workmanship.
  2. Build mockups of decorative concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Architect and not less than 48" by 60".
  3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- G. Preinstallation Conference:
  1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Checklist documents in the Standard Training & Documentation: Documents \ 03 – Training and Guidance \ 03 – Role Based Training and Guidance Documents \ Contractors
  2. Conduct conference at project site.
  3. Review methods and procedures related to decorative concrete paving, including but not limited to, the following:
    - a. Concrete mixture design.
    - b. Quality control of concrete materials and decorative concrete paving construction practices.

## 1.7 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
  - 1. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
  - 2. Do not use frozen materials or materials containing ice or snow.
  - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
- C. Hot-Weather Concrete Placement: Comply with ACI 301 (ACI 301M) and Section 32 13 13 "Concrete Paving"

## PART 2 - PRODUCTS

### 2.1 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
  - 1. Use flexible or uniformly curved forms for curves of a radius of 100 feet or less. Do not use notched and bent forms.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

### 2.2 STEEL REINFORCEMENT

- A. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, welded wire mesh, roll type, size as indicated.
- B. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) plain-steel bars. Cut bars true to length with ends square and free of burrs.
- C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:
  - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

### 2.3 CONCRETE MATERIALS

- A. See Section 32 13 13 "Concrete Paving" Air-Entraining Admixture: ASTM C 260 shall be used to achieve an entrained air content for the particular mix used in accordance with the published recommendations of the Portland Cement Association and the ACI.

- B. Chemical Admixtures: no admixtures using calcium chloride shall be permitted.
  1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
  2. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
- C. Curing Compound for Colored Concrete: Curing compound shall comply with ASTM C309 and be approved by color additive manufacturer for use with colored concrete.
- D. Do not use fly ash or slag in colored concrete.

#### 2.4 CONCRETE COLORING MATERIALS

- A. Iron Oxide Pigment: ASTM C 979-82, predispersed iron oxide pigments containing high pigment solids in aqueous base liquid, color stable with uniform and consistent color, permanent, inert, stable to atmospheric conditions, sunfast, weather resistant, alkali resistant, water insoluble, lime proof and nonbleeding.
- B. Manufacturer: Subject to the requirements, provide products from the one of the following manufacturers or equal as approved by the Professional.
  1. Davis Colors
  2. Solomon Colors
  3. SIKA USA
  4. Color: to be selected from manufacturer's standard colors.

#### 2.5 RELATED MATERIALS

- A. Joint Fillers:
  1. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
  2. Material: ASTM D 1752, self-expanding cork in preformed strips.
- B. Polyethylene Film: ASTM D 4397, 1 mil (0.025 mm) thick, clear.
- C. Colored Joint Sealant: To match colored concrete.

#### 2.6 CONCRETE MIXTURES

- A. See Section 32 13 13 "Concrete Paving" Chemical Admixtures: Use admixtures designed for use with concrete pigments, use according to manufacturer's written instructions.
  1. Use water-reducing admixture or water-reducing and retarding admixture in concrete as required for placement and workability.
  2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
- B. Cementitious Materials: Do not substitute slag or fly ash for portland cement.
- C. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

## 2.7 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.
  - 1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.
  - 1. For concrete batches of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
  - 2. For concrete batches larger than 1 cu. yd. ,increase mixing time by 15 seconds for each additional 1 cu. yd.
  - 3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine subbase surfaces for compliance with requirements for dimensional, slope, and elevation tolerances.
- B. Proof-roll prepared subbase surface below decorative concrete paving to identify soft pockets and areas of excess yielding.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Remove loose material from subbase surface immediately before placing concrete.
- B. Protect adjacent construction from discoloration and spillage during application of color hardeners, release agents, stains, curing compounds, and sealers.

### 3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

### 3.4 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

### 3.5 JOINTS

- A. General:
  - 1. Jointing details and materials should be consistent with adjacent cement concrete paving, as practical.
  - 2. Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
  - 1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
  - 2. Butt Joints: Use bonding agent or epoxy bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
  - 3. Dowelled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
  - 1. Locate expansion joints at intervals of 20 feet unless otherwise indicated.
  - 2. Extend joint fillers full width and depth of joint.
  - 3. Terminate joint filler not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished surface if joint sealant is indicated.
  - 4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
  - 5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
  - 6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
  - 7. Install backer material as required to support sealant and at a cross sectional shape to allow maximum sealant movement.
  - 8. Seal joints with approved joint sealant per manufacturer's instructions. Remove excess sealant from sides of joint.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of adjacent concrete paving:
  - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch (6-mm) radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.
  - 2. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.



- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 3/8-inch (10-mm) radius. Repeat tooling of edges after applying surface finishes. Eliminate edging tool marks on concrete surfaces.

### 3.6 CONCRETE PLACEMENT

- A. See Section 32 13 13 "Concrete Paving".
- B. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and as follows when hot-weather conditions exist:
  - 1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  - 2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
  - 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

### 3.7 FLOAT FINISHING

- A. See Section 32 13 13 "Concrete Paving".

### 3.8 CONCRETE PROTECTION AND CURING

- A. See Section 32 13 13 "Concrete Paving"

### 3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Conform to requirements of Section 033000 "Cast In Place Concrete"

### 3.10 REPAIRS AND PROTECTION

- A. Remove and replace decorative concrete paving that is broken or damaged or does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.
- B. Detailing: Grind concrete "squeeze" left from tool placement. Color ground areas with slurry of color hardener mixed with water and bonding agent. Remove excess release agent with high-velocity blower.
- C. Protect decorative concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain decorative concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

**END OF SECTION 32 13 16**

## SECTION 32 31 19

### DECORATIVE METAL FENCES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions" and "Division 1 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Decorative aluminum fences and gates
- B. Related Requirements:
  - 1. Section 08 71 00 "Door Hardware" for gate hardware.

##### 1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design decorative fences and gates, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
  - 1. Provide fencing system including top and bottom rails, single and double swing gates with appropriate cross bracing and post size, post caps, closing and locking hardware.
  - 2. Gate hardware and operation to be coordinated with the building security system. Gates from courtyards must provide emergency egress but be non-functional in non-emergency conditions. Fencing and gates must not be climbable.
  - 3. Coordinate with segmental retaining wall manufacturer for fencing behind retaining wall.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Shop Drawings: For fence panels and gates. Include plans, elevations, sections, details, hardware and attachments to other work. Include diagrams for power, signal, and control wiring.
- B. Samples: For each fence material and for each color specified.

##### 1.5 DELIVERY, STORAGE AND HANDLING

- A. Provide manufacturer's standard limited warranty that its ornamental fence system is free from defects in material and workmanship including cracking, peeling, blistering and corroding for a period of 15 years from the date of purchase.

## PART 2 - PRODUCTS

### 2.1 DECORATIVE ALUMINUM FENCES

- A. Decorative Aluminum Fences: Fences made from aluminum extrusions for commercial applications.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide fencing from the following manufacturer: Ameristar / Assa Abloy, Echelon II for 8 foot fencing and gates, Echelon Plus for 3'-6" fencing, or equal as approved by the Professional:
    - a. Master Halco
    - b. Jerith Manufacturing
- B. Posts: Square extruded tubes, 2.5 by 2.5 inches minimum; post size varies per height per manufacturers with 0.093-inch wall thickness.
- C. Post Caps: Aluminum castings.
- D. Rails: Extruded-aluminum channels
  - a. 8 foot fence and gate: three rail, as indicated on Drawings
  - b. 3'-6" fence; three rail, as indicated on Drawings
- E. Pickets: Extruded-aluminum tube
  - a. 8 foot fence and gate: as indicated on Drawings
  - b. 3'-6" fence: as indicated on Drawings
- 2. Picket Spacing: 4 inches clear, maximum.
- F. Fasteners: Manufacturer's standard tamperproof, corrosion-resistant, color-coated fasteners matching fence components.
- G. Fabrication: Assemble fences into sections by fastening pickets to rails.

### 2.2 SWING GATES

- A. Aluminum Frames and Bracing: Fabricate members from square extruded-aluminum tubes with wall thickness.
- B. Hardware: Exterior hardware to be key card access. Courtyard interior to be panic bar hardware connected to security system.
- C. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A 123/A 123M. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.
- D. Aluminum Finish: Baked enamel or powder coating.

### 2.3 MISCELLANEOUS MATERIALS

- A. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 03 30 00 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi, 3-inch slump, and 1-inch maximum aggregate size.

## 2.4 GROUNDING MATERIALS

- A. Grounding Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.
  - 1. Material above Finished Grade: Aluminum.
  - 2. Material on or below Finished Grade: Copper.
- B. Grounding Connectors and Grounding Rods: Comply with UL 467.

## 2.5 ALUMINUM FINISHES

- A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 2 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
  - 1. Color and Gloss: Bronze

## PART 3 - EXECUTION

### 3.1 DECORATIVE FENCE INSTALLATION

- A. Install fences according to manufacturer's written instructions.
- B. Post Setting in concrete footings: Set posts in concrete footings at indicated spacing into firm, undisturbed soil.
  - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
  - 2. Extend post to within 6 inches of specified excavation depth, but not closer than 3 inches to bottom of concrete.
  - 3. Space posts uniformly at 8 feet o.c. or as indicated on drawings.
- C. Posts Set into Concrete in Sleeves: Use galvanized-steel pipe sleeves with inside diameter at least 3/4 inch larger than outside diagonal dimension of post, preset and anchored into concrete for installing posts.
  - 1. Extend posts at least 5 inches into sleeve.
  - 2. After posts have been inserted in sleeves, fill annular space between post and sleeve with nonshrink grout, mixed and placed to comply with grout manufacturer's written instructions; shape and smooth to shed water. Finish and slope top surface of grout to drain water away from post.
- D. Posts Set with Mechanical Anchors on Walls:
  - 1. Provide base plates on all posts to receive anchor bolts.
  - 2. Anchor fence into concrete wall and provide anchor bolts as shown on shop drawings.

### 3.2 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

### 3.3 GROUNDING AND BONDING

- A. Fence Grounding: Install at maximum intervals of 1500 feet except as follows:
  - 1. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet.
    - a. Gates and Other Fence Openings: Ground fence on each side of opening. Bond metal gates to gate posts.
- B. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.
- C. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.
- D. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
- E. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

**END OF SECTION 32 31 19**

## SECTION 32 32 23

### SEGMENTAL RETAINING WALLS

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.2 SUMMARY

- A. This Section includes single-depth segmental retaining walls

##### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

##### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each color and texture of concrete unit specified. Submit sections of units not less than 6 inches square.
- C. Delegated-Design Submittal: For segmental retaining walls. To be signed and sealed by professional engineer licensed in the State of Pennsylvania.

##### 1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of segmental retaining wall unit and soil reinforcement from manufacturer.
  - 1. Include test data for shear strength between segmental retaining wall units according to ASTM D 6916.
- B. Product Test Reports: For each type of segmental retaining wall unit and soil reinforcement, for tests performed by a qualified testing agency.
  - 1. Include test data for freeze-thaw durability of segmental retaining wall units.
  - 2. Include test data for shear strength between segmental retaining wall units according to ASTM D 6916.

##### 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects.

1. Build mockup of segmental retaining wall approximately 72 inches long by not less than 36 inches high above finished grade at front of wall.
  - a. Include typical soil reinforcement.
  - b. Include typical base and cap or finished top construction.
  - c. Include backfill to typical finished grades at both sides of wall.
  - d. Include typical end construction at one end of mockup.
  - e. Include 36-inch return at one end of mockup, with typical corner construction.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
3. ASTM D 5321.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store and handle concrete units and accessories to prevent deterioration or damage due to contaminants, breaking, chipping, or other causes.
- B. Store geosynthetics in manufacturer's original packaging with labels intact. Store and handle geosynthetics to prevent deterioration or damage due to sunlight, chemicals, flames, temperatures above 160 deg F or below 32 deg F, and other conditions that might damage them. Verify identification of geosynthetics before use, and examine them for defects as material is placed.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, to design segmental retaining walls.
- B. Compliance Review: Qualified professional engineer responsible for segmental retaining wall design shall review and approve submittals and source and field quality-control reports for compliance of materials and construction with design.
- C. Structural Performance: Engineering design shall be based on the following loads and be according to NCMA's "Design Manual for Segmental Retaining Walls."
  1. Gravity loads due to soil pressures resulting from grades indicated.

#### 2.2 SEGMENTAL RETAINING WALL UNITS

- A. Concrete Units: ASTM C 1372, Normal Weight, except that maximum water absorption shall not exceed 7 percent by weight and units shall not differ in height more than plus or minus 1/16 inch from specified dimension.
  1. Basis of Design Product: Subject to compliance with requirements, provide product from the following manufacturer: York Building Products, Mesa Retaining Wall System or comparable product from one of the following, or equal as approved by the Professional:
    - a. Keystone Retaining Wall Systems, Key System I and II
    - b. Anchor Wall Systems, Diamond Pro, Straight Face
  2. Provide units that comply with requirements in ASTM C 1372 for freeze-thaw durability.
  3. Provide units that interlock with courses above and below by means of integral lugs, lips, or tongues and grooves pins clips splines and hollow cores filled with drainage fill.

- 4. Provide system that is near vertical.
- B. Color: As selected by Architect from manufacturer's full range.
- C. Shape and Texture: Provide units with machine-split textured or smooth exposed face.
- D. Cap Units: Provide cap units of same shape as other units with smooth, as-cast top surfaces without holes or lugs.
- E. Special Units: Provide corner units, end units, and other shapes as needed to produce segmental retaining walls of dimensions and profiles indicated and to provide texture on exposed surfaces matching face.

### 2.3 INSTALLATION MATERIALS

- A. Pins: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from nondegrading polymer reinforced with glass fibers.
- B. Clips: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from nondegrading polymer reinforced with glass fibers.
- C. Cap Adhesive: Product supplied or recommended by segmental retaining wall unit manufacturer for adhering cap units to units below.
- D. Drainage Fill: Comply with requirements in Section 312000 "Earth Moving" for drainage course.
- E. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent.
  - 1. Apparent Opening Size: No. 70 to 100 sieve, maximum; ASTM D 4751.
  - 2. Minimum Grab Tensile Strength: 110 lb; ASTM D 4632.
  - 3. Minimum Weight: 4 oz./sq. yd..

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for excavation tolerances, condition of subgrades, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 RETAINING WALL INSTALLATION

- A. General: Place units according to NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions.
  - 1. Lay units in running bond.
  - 2. Form corners and ends by using special units.
- B. Do not use units with chips, cracks, or other defects that are visible at a distance of 20 feet where such defects are exposed in the completed Work.



- C. Leveling Base: Place and compact base material to thickness indicated and with not less than 95 percent maximum dry unit weight according to ASTM D 698.
- D. First Course: Place first course of segmental retaining wall units for full length of wall. Place units in firm contact with each other, properly aligned and level.
  - 1. Tamp units into leveling base as necessary to bring tops of units into a level plane.
- E. Subsequent Courses: Remove excess fill and debris from tops of units in course below. Place units in firm contact, properly aligned, and directly on course below.
  - 1. For units with lugs designed to fit into holes in adjacent units, lay units so lugs are accurately aligned with holes, and bedding surfaces are firmly seated on beds of units below.
  - 2. For units with lips at front of units, slide units as far forward as possible for firm contact with lips of units below.
  - 3. For units with lips at bottom rear of units, slide units as far forward as possible for firm contact of lips with units below.
  - 4. For units with pins, install pins and align units.
  - 5. For units with clips, install clips and align units.
- F. Cap Units: Place cap units and secure with cap adhesive.

### 3.3 FILL PLACEMENT

- A. General: Comply with requirements in Section 312000 "Earth Moving," with NCMA's "Segmental Retaining Wall Installation Guide," and with segmental retaining wall unit manufacturer's written instructions.
- B. Fill voids between and within units with drainage fill. Place fill as each course of units is laid.
- C. Place, spread, and compact drainage fill and soil fill in uniform lifts for full width and length of embankment as wall is laid. Place and compact fills without disturbing alignment of units. Where both sides of wall are indicated to be filled, place fills on both sides at same time. Begin at wall, and place and spread fills toward embankment.
  - 1. Use only hand-operated compaction equipment within 48 inches of wall, or one-half of height above bottom of wall, whichever is greater.

### 3.4 CONSTRUCTION TOLERANCES

- A. Variation from Level: For bed-joint lines along walls, do not exceed 1-1/4 inches in 10 feet, 3 inches maximum.
- B. Variation from Indicated Batter: For slope of wall face, do not vary from indicated slope by more than 1-1/4 inches in 10 feet.
- C. Variation from Indicated Wall Line: For walls indicated as straight, do not vary from straight line by more than 1-1/4 inches in 10 feet.
- D. Maximum Gap between Units: 1/8 inch.

### 3.5 ADJUSTING

- A. Remove and replace segmental retaining wall construction of the following descriptions:

1. Broken, chipped, stained, or otherwise damaged units. Units may be repaired if Architect approves methods and results.
  2. Segmental retaining walls that do not match approved Samples and mockups.
  3. Segmental retaining walls that do not comply with other requirements indicated.
- B. Replace units so segmental retaining wall matches approved Samples and mockups, complies with other requirements, and shows no evidence of replacement.

END OF SECTION 32 32 23

## SECTION 32 33 00

### SITE FURNISHINGS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions" and "Division 1 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section includes
  1. Benches
  2. Gliders
  3. Tables and Chairs
  4. Umbrella
  5. Lounge Furniture
  6. Trash Receptacle
  7. Planters
  8. Television

##### 1.3 ACTION SUBMITTALS

- A. Product Data: Manufacturer's product data for each type of product. Samples of materials requiring color or fabric selection.
- B. Samples for Verification: For each color and texture specified.

##### 1.4 INFORMATIONAL SUBMITTALS

- A. Installation manuals
- B. Maintenance manuals

#### PART 2 - PRODUCTS

##### 2.1 BENCH

- A. Products:
  1. Public entrances, courtyards and pathways
    - a. Basis-of-design: Subject to compliance with the requirements, provide Anova Elevation or a comparable product by one of the following, or equal as approved by the Professional:
      - 1) Victor Stanley Stell
      - 2) Maglin 450 Backed Bench
    - b. Product name: Anova
      - 1) Style: Elevation 6' Recycled Plastic Bench

- 2) Length – 72"
- 3) Steel: Hot-dip galvanized and powder-coated
- 4) Color (metal frame): to be selected from manufacturers standard colors
- 5) Installation: Surface mount

## 2.2 GLIDERS

### A. Products:

- a. Basis-of-design: Subject to compliance with the requirements, provide kwalu senior living furniture or a comparable product by one of the following, or equal as approved by the Professional:
  - 1) Polywood Traditional Garden Glider
- b. Product: Kwalu glider
  - 1) Model: AREG2P Arezzo Glider Love Seat with Back & Seat Cushions
  - 2) Size: 49"W x 20"D x 20"H
  - 3) Material: Steel frame with polymer coating
  - 4) Accessories: Floor Mounting Bracket

## 2.3 TABLES AND CHAIRS – SHADE STRUCTURES

### A. Products: Tables

- a. Basis-of-design: Subject to compliance with the requirements, provide kwalu senior living furniture or a comparable product by one of the following, or equal as approved by the Professional:
  - 1) Kellex Tranquility Grove Dining Table
  - 2) Anova 42" ADA Table
- b. Product: kwalu
  - 1) Model: ARGIW Arezzo Dining Table
  - 2) Size: 42" square dining table
  - 3) Height: wheelchair height
  - 4) Material: steel frame with polymer coating

### B. Products: Chairs

- a. Basis-of-design: Subject to compliance with the requirements, provide kwalu senior living furniture or a comparable product by one of the following, or equal as approved by the Professional:
  - 1) Kellex Tranquility Hawthorne Dining Chair
  - 2) Anova Elevation Recycled Plastic Lounge Chair
- b. Product: kwalu
  - 1) Model: Arezzo Dining Chair
  - 2) Material: steel frame with polymer coating

## 2.4 TABLES AND CHAIRS – DINING TERRACE

### A. Products: Tables

- a. Basis-of-design: Subject to compliance with the requirements, provide Texacraft or a comparable product by one of the following, or equal as approved by the Professional:
  - 1) Anova 42" ADA Table
  - 2) Kellex Tranquility Grove Dining Table
- b. Product: Texacraft
  - 1) Model: Meza ADA Table with Umbrella Hole
  - 2) Material: powdercoated aluminum

- B. Products: Chairs
  - a. Basis-of-design: Subject to compliance with the requirements, provide Texacraft or a comparable product by one of the following, or equal as approved by the Professional:
    - 1) Anova Elevation Recycled Plastic Lounge Chair
    - 2) Kellex Arbor Dining Chair
  - b. Product: Texacraft
    - 1) Model: Meza Nesting Dining Chair
    - 2) Material: powdercoated aluminum

## 2.5 UMBRELLA

- A. Products:
  - a. Basis-of-design: Subject to compliance with the requirements, provide Texacraft or a comparable product by one of the following, or equal as approved by the Professional:
    - 1) Anova Lucaya 8' diameter umbrella with base
    - 2) Thomas Steele classic umbrella
  - b. Product: Texacraft
    - 1) Model: Lucaya 8' diameter umbrella with base
    - 2) Size: 8' octagon
    - 3) Frame: aluminum
    - 4) Base: weighted base
    - 5) Color: to be selected from manufacturers standard finishes
    - 6) Fabric: to be selected from manufacturer's standard fabric and colors

## 2.6 LOUNGE FURNITURE – SHADE STRUCTURES

- A. Products: Chairs
  - a. Basis-of-design: Subject to compliance with the requirements, provide kwalu senior living furniture or a comparable product by one of the following, or equal as approved by the Professional:
    - 1) Kellex Hawthorne Lounge Chair
    - 2) Polywood Loveseat
    - 3) Telescope Casual Belle Isle Three Seat Sofa
  - b. Product: kwalu
    - 1) Model: Arezzo lounge chair
    - 2) Size: 28" wide
    - 3) Color: to be selected from manufacturers standard finishes
    - 4) Fabric: to be selected from manufacturer's standard fabric and colors
- B. Products: Love Seat or Sofa
  - a. Basis-of-design: Subject to compliance with the requirements, provide kwalu senior living furniture or a comparable product by one of the following, or equal as approved by the Professional:
    - 1) Kellex Hawthorne Love Seat
    - 2) Polywood Love Seat
    - 3) Telescope Casual Belle Isle three seat sofa
  - b. Product: kwalu
    - 1) Model: Arezzo love seat
    - 2) Size: 54" wide
    - 3) Color: to be selected from manufacturers standard finishes
    - 4) Fabric: to be selected from manufacturer's standard fabric and colors

- C. Products: Coffee Table
  - a. Basis-of-design: Subject to compliance with the requirements, provide kwalu senior living furniture or a comparable product by one of the following, or equal as approved by the Professional:
    - 1) Kellex Grove cocktail table
    - 2) Polywood Newport 28" x 42" coffee table
    - 3) Telescope Casual Rectangular Origins coffee table
  - b. Product: kwalu
    - 1) Model: ARBI Arezzo coffee table
    - 2) Size: 36" diameter
    - 3) Color: to be selected from manufacturers standard finishes

## 2.7 TRASH RECEPTACLE

- A. Products: Trash Receptacles
  - a. Basis-of-design: Subject to compliance with the requirements, provide Victor Stanley or a comparable product by one of the following, or equal as approved by the Professional:
    - 1) Anova Metrix 40 gallon trash receptacle
    - 2) Maglin 250 Trash Container
  - b. Product: Victor Stanley
    - 1) Model: SDC-36
    - 2) Size: 36 gallon
    - 3) Color: Bronze

## 2.8 PLANTERS

- A. Products: Rectangular planters
  - a. Basis-of-design: Subject to compliance with the requirements, provide Old Town Fiberglass Planters or a comparable product by one of the following, or equal as approved by the Professional:
    - 1) Tournesol Urban Collection
    - 2) NewPro Containers: Jay Scotts Planter Collection
  - 2. Product: Old Town
    - a. Material: fiberglass
    - b. Model #: CF2432
    - c. Size:
      - 1) 24" x 24" x 32" H
    - d. Options: Provide drainage fittings
    - e. Color: Color to be selected from manufacturers full range
- B. Products: Accessible / raised planters
  - a. Basis-of-design: Subject to compliance with the requirements, provide Accessible Gardens or a comparable product by one of the following, or equal as approved by the Professional:
    - 1) Gardner's Supply VegTrug Pation Garden
    - 2) World of Greenhouses ADA Wheelchair Accessible Cedar Garden Bed
  - 2. Product:
    - a. Material: Cedar
    - b. Model: ADA-Compliant Forward Facing Wheelchair Garden
      - 1) Size: 48" x 45" x 30" H

## 2.9 EXTERIOR TELEVISION

### A. Products:

- a. Basis-of-design: Subject to compliance with the requirements, provide Samsung or a comparable product by one of the following, or equal as approved by the Professional:
  - 1) Sunbrite TV 55" Pro Series Ultra-Bright Outdoor TV
- b. Product: Samsung
  - 1) Model: 55" Class Outdoor QLED Smart TV
  - 2) Name: The Terrace Partial Sun
  - 3) Wall Mount: The Terrace Wall Mount

## PART 3 -EXECUTION

### 3.1 INSTALLATION

1. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.
2. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.
3. Install site furnishings level, plumb, true, and securely anchored or positioned at locations indicated on Drawings.

**END OF SECTION 32 33 00**

## SECTION 32 91 13

### SOIL PREPARATION

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

##### 1.2 SUMMARY

- A. Section includes planting soils specified by composition of the mixes, for planting on grade.
- B. Related Requirements:
  - 1. Section 32 92 00 "Lawns" for seeding and sodding.
  - 2. Section 32 93 00 "Planting" for planting.

##### 1.3 DEFINITIONS

- A. Imported Soil: Soil that is transported to Project site for use.
- B. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- C. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- D. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- E. Imported Soil: Soil that is transported to Project site for use.

##### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference:
  - 1. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation checklist documents in the Standard Training & Documentation: Document / 03-Training and Guidance / 03 – Role Based Training and Guidance Documents / Contractors.
  - 2. Conduct conference at Project site.

##### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each bulk-supplied material, 1/2-gallon volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.



## 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed, and will provide recommendations for soil amendments.

## 1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil, imported soil and compost. .
- B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.

## 1.8 EXISTING SOIL-SAMPLING REQUIREMENTS

- A. General: Extract soil samples according to requirements in this article.
- B. Sample Collection and Labeling: Have samples taken and labeled by state-certified, licensed, or registered soil scientist or landscape contractor under the direction of the testing agency.
  - 1. Number and Location of Samples:
    - a. After rough grading is complete and at subgrade elevation and before placement of planting soil, collect a minimum of ten representative soil samples from varied locations for each soil to be used or amended for landscaping purposes.
    - b. Provide a minimum of two representative soil samples from stockpiled topsoil if available.
  - 2. Procedures and Depth of Samples: per instructions from the testing laboratory.
  - 3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.
  - 4. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

## 1.9 IMPORTED SOIL, COMPOST AND PLANTING SOIL MIX TESTING

- A. Provide soil test results and recommendations for all imported topsoil, manufactured planting soil and compost per Testing Requirements article.
- B. Provide soil test and recommendations for each 500 CY of imported topsoil, and planting soil.
- C. Provide soil test and recommendations for each planting soil mix per article 2.3 Planting Soils by Composition.

## 1.10 TESTING REQUIREMENTS

- A. General: Perform tests on soil samples according to requirements in this article.
- B. Physical Testing:

1. Soil Texture: Soil-particle, size-distribution analysis by one of the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":
    - a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
    - b. Hydrometer Method: Report percentages of sand, silt, and clay.
  2. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
- C. Fertility Testing: Soil-fertility analysis according to standard laboratory protocol of , including the following:
1. Percentage of organic matter.
  2. CEC, calcium percent of CEC, and magnesium percent of CEC.
  3. Soil reaction (acidity/alkalinity pH value).
  4. Buffered acidity or alkalinity.
  5. Nitrogen ppm.
  6. Phosphorous ppm.
  7. Potassium ppm.
  8. Manganese ppm.
  9. Manganese-availability ppm.
  10. Zinc ppm.
  11. Zinc availability ppm.
  12. Copper ppm.
  13. Sodium ppm.
  14. Soluble-salts ppm.
- D. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
- E. Compost testing: Also provide C:N ratio.
- F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for compost, nitrogen, phosphorous, and potassium fertilization, and for micronutrients. Provide recommendations for addition of organic compost in lieu of inorganic fertilizer.
1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. for 6-inch depth of soil.
  2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. for 6-inch depth of soil .
- 1.11 DELIVERY, STORAGE, AND HANDLING
- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.
  - B. Bulk Materials:
    1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Do not move or handle materials when they are wet or frozen.
4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Regional Materials: Imported soil manufactured planting soil and soil amendments and fertilizers shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

### **2.2 TOPSOIL**

- A. Imported, naturally formed soil from off-site sources and consisting of sandy loam or loam soil according to USDA textures.
- B. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches deep, not from agricultural land, bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and brome grass.
- C. Additional properties of imported topsoil before amending: Soil reaction of pH 6 to 7 and minimum of 2 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration.

### **2.3 PLANTING SOILS SPECIFIED BY COMPOSITION**

- A. General: Soil amendments, fertilizers, and rates of application specified in this article are guidelines that may need revision based on testing laboratory's recommendations after preconstruction soil analyses are performed.
  1. Planting-Soil Type: Tree Planting
    - a. Mix one half (1/2) existing soil, one quarter (1/4) stockpiled or imported topsoil and one quarter (1/4) compost by volume with additional amendments per soil test recommendations.
  2. Planting-Soil Type: Shrub Planting: Same as tree planting.
  3. Planting-Soil Type: Lawns: mix three quarters (3/4) stockpiled or imported topsoil with one quarter (1/4) compost.

### **2.4 INORGANIC SOIL AMENDMENTS**

- A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through a No. 8 sieve and a minimum of 75 percent passing through a No. 60 sieve.
  2. Class: O, with a minimum of 95 percent passing through a No. 8 sieve and a minimum of 55 percent passing through a No. 60 sieve.
  3. Form: Provide lime in form of ground dolomitic limestone.
- B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 sieve and a maximum of 10 percent passing through a No. 40 sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 sieve.
- E. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C 33/C 33M .

## 2.5 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter, Leafgro or approved equal, and as follows:
1. Reaction: pH of 5.5 to 7.
  2. Soluble-Salt Concentration: Less than 4 dS/m.
  3. Moisture Content: 35 to 55 percent by weight.
  4. Carbon:Nitrogen Ratio: less than 25:1
  5. Organic-Matter Content: 30 to 40 percent of dry weight.
  6. Particle Size: Minimum of 98 percent passing through a 2-inch sieve.

## 2.6 FERTILIZERS

- A. *Apply fertilizer only if recommended by soil testing results.*
- B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
  2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.
- C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
  2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.
- D. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Place planting soil and fertilizers according to requirements in other Specification Sections.
- B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.

### 3.2 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth of 6 inches. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Mixing: Spread unamended soil to total depth of 8 inches, but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
  - 1. Amendments: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.
    - a. Mix lime and sulfur with dry soil before mixing fertilizer.
    - b. Mix fertilizer with planting soil no more than seven days before planting.
  - 2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 8 inches in loose depth for material compacted by compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- D. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698 and tested in-place.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

### 3.3 PLACING MANUFACTURED (Pre-Blended) PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply manufactured soil on-site in its final, blended condition. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth of 6 inches. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Application: Spread planting soil to total depth of 8 inches, but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
  - 1. Lifts: Apply planting soil in lifts not exceeding 8 inches in loose depth for material compacted by compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- D. Compaction: Compact each lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698.

- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections:
  - 1. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D 698. Space tests at no less than one for each 2000 sq. ft. of in-place soil or part thereof.
- C. Soil will be considered defective if it does not pass tests and inspections.
- D. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

### 3.5 PROTECTION

- A. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
  - 1. Storage of construction materials, debris, or excavated material.
  - 2. Parking vehicles or equipment.
  - 3. Vehicle traffic.
  - 4. Foot traffic.
  - 5. Erection of sheds or structures.
  - 6. Impoundment of water.
  - 7. Excavation or other digging unless otherwise indicated.
- B. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

**END OF SECTION 32 91 13**

## SECTION 32 92 00

### LAWNS

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions" and "Division 1 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section Includes:
  - 1. Lawn Seeding.
  - 2. Lawn Sodding.
- B. Related Requirements:
  - 1. Section 32 91 13 "Soil Preparation"
  - 2. Section 32 93 00 "Planting"

##### 1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 32 91 13 "Soil Preparation".
- C. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

##### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

##### 1.5 INFORMATIONAL SUBMITTALS

- A. Certification of grass seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
- B. Certification of each seed mixture for turfgrass sod.
- C. Product certificates: For fertilizers, from manufacturer.

## 1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

## 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.
  - 1. Experience: Five years' experience in turf installation in addition to requirements in Section 01 40 00 "Quality Requirements."
  - 2. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.
- B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.
- C. Bulk Materials:
  - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
  - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
  - 3. Accompany each delivery of bulk materials with appropriate certificates.

## 1.9 FIELD CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods, or as approved by the Landscape Architect due to weather conditions. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.
  - 1. Seeded lawns:
    - a. Spring Planting: March 15 – June 1
    - b. Fall Planting: September 1– October 15,
  - 2. Sodded lawns: May be planted unless the ground is frozen or temperatures will exceed 90 degrees F.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

## 1.10 ACCEPTANCE AND WARRANTY

- A. An inspection of work completed shall be conducted by the Landscape Architect and Owner's Representative for the purpose of initial acceptance. Any outstanding items revealed on inspection



and identified on the punch list shall be corrected with two weeks. Initial acceptance shall be withheld until those items are completed. Warranty, for a period of one year, shall begin after landscape inspection and initial acceptance.

- B. Warrant in writing that all lawns, placed on this Project will remain alive and be in healthy vigorous condition for a period of 1 year after completion and initial acceptance of entire project.
- C. During the warranty period replace, in accordance with the drawings and specifications, all lawns that are in an unhealthy or unsightly condition, or more than 25% dead.
- D. Final Inspection and Acceptance: An inspection will be conducted with the Landscape Contractor, Landscape Architect and Owner at the end of the one year warranty period for purposes of Final Acceptance.
- E. Warranty shall not include damage or loss of plants due to vandalism, fire, severe winds, extreme cold, or negligence on the Owner's part.
- F. Owner's maintenance shall begin upon initial acceptance of plant material.

## **PART 2 - PRODUCTS**

### **2.1 SEED**

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances. Quality, State Certified: State-certified seed of grass species appropriate for solar exposure.
- B. Grass-Seed Mix: Provide state certified turf grass blend as follows:
  - 1. 90 – 95% blend of a minimum of three dark green turf-type tall fescue seeds and 10-15% Kentucky Bluegrass.
  - 2.

### **2.2 TURFGRASS SOD**

- A. Turfgrass Sod: Certified, Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is strongly rooted and capable of vigorous growth and development when planted.
  - 1. 90 – 95% Tall Fescue blend and 5 – 10% maximum Kentucky Bluegrass
- B. Turfgrass Species:
  - 1. Products: Subject to compliance with requirements, provide the following
  - 2. Sod of grass species as follows:
    - a. Full Sun and Part Shade: Newsom Trio Mix, or approved equal.
    - b. Full Shade: Newsom Shade Mix or approved equal

### **2.3 FERTILIZERS**

- A. General: Apply fertilizer only if recommended per soil test report recommendations and Section 32 91 13 "Soil Preparation".

## 2.4 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

## 2.5 PESTICIDES

- A. General: Do not apply inorganic pesticides.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
  - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
  - 2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
  - 3. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil

### 3.2 PREPARATION

- A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

### 3.3 TURF AREA PREPARATION

- A. General: After finish grading of subgrade, loosen surface by tilling or raking.
- B. Mix planting soil according to Section 32 91 13 "Soil Preparation."
- C. Placing Planting Soil: Place and mix planting soil in place over exposed subgrade OR place manufactured planting soil over exposed subgrade.
- D. Reduce elevation of planting soil to allow for soil thickness of sod.
- E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

- F. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

### 3.4 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
  - 1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
  - 2. Do not use wet seed or seed that is moldy or otherwise damaged.
  - 3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate of 3 to 4 lb/1000 sq. ft.
- C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes exceeding 1:3 with erosion-control blankets installed and stapled according to manufacturer's written instructions.
- E. Protect seeded areas with slopes not exceeding 1:3 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas.
  - 1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
- F. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

### 3.5 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
  - 1. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
  - 2. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
- C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

### 3.6 TURF MAINTENANCE

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
  - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
  - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
  - 3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
  - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
  - 2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.
- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings.

### 3.7 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Architect:
  - 1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
  - 2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
- B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

### 3.8 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.
- C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- D. Remove nondegradable erosion-control measures after grass establishment period.

### 3.9 MAINTENANCE SERVICE

- A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:
1. Seeded Turf: 60 days from date of planting completion or until all planting completion and initial acceptance, whichever is longer.
    - a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.
  2. Sodded Turf: 30 days from date of planting completion or until all planting completion and initial acceptance, whichever is longer.

END OF SECTION 32 92 00

## SECTION 32 93 00

### PLANTING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions" and "Division 1 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUMMARY

- A. Section includes:
  - 1. Deciduous and evergreen tree and shrub planting
- B. Related sections include:
  - 1. Section 32 91 13 "Soil Preparation"
  - 2. Section 32 92 00 "Lawns"

##### 1.3 SUBMITTALS

- A. Submit a list of all nurseries that will supply plants.
- B. Qualification Data: For qualified landscape Installer.
- C. Soil Samples and Soil Test Reports: See 32 91 13 "Soil Preparation"
- D. Plant Photographs: Submit color photographs of representative specimens of each type of tree on the plant list. Photos shall be 3"x5" taken from an angle that depicts the size and condition of the typical plant to be furnished. A scale rod or other measuring device shall be included in the photograph. Label each photograph with the plant name, size and name of growing nursery.
- E. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of exterior plants during a calendar year. Submit before expiration of required maintenance periods.

##### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Installer shall have not less than 5 years documented successful experience in meadow installations and be a member of the Landscape Contractors Association. Installer shall submit evidence of qualifications including photographs, locations and references of owners for review by the Landscape Architect and the Owners Representative.
- B. Plant material observation: Landscape Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size and quality. Landscape Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
  - 1. Notify Landscape Architect two weeks in advance of plant observation / tagging schedule.

2. Notify Landscape Architect of sources of planting materials seven days in advance of delivery to site.
- C. The contractor shall maintain continuously a competent supervisor, satisfactory to the Owner's Representative, with authority to act in all matter pertaining to this work.
- D. Conference: Before any work is started a conference shall be held between the Contractor, the Owner's Representative and the Landscape Architect concerning the work under this contract.
- E. Provide quality, size, genus, species, and variety of exterior plants indicated, complying with applicable requirements in ANSI Z60.1, "American Standard for Nursery Stock."
- F. It is the Landscape Contractor's responsibility to coordinate and cooperate with the other Contractors to enable work to proceed rapidly and efficiently. Coordinate with all adjacent Contractors' work including all paving, lawn, electrical, etc.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver exterior plants freshly dug.
- B. Do not prune trees and shrubs before delivery except as approved by Landscape Architect. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of exterior plants during delivery.
- C. Deliver exterior plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set exterior plants and trees in shade, protect from weather and mechanical damage, and keep roots moist. Plants shall not be stored on site longer than 1 week.

#### 1.6 PROJECT CONDITIONS

- A. Plant material should be installed within the following dates: March 15 – June 1 or August 15 – October 15, or as approved by the Landscape Architect due to weather conditions. Plant material may not be dug after May 15.
- B. Weather limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

#### 1.7 MAINTENANCE SERVICE

- A. Initial Planting Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until completion of building construction and initial acceptance of all plant material.
- B. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

## 1.8 ACCEPTANCE AND WARRANTY

- A. An inspection of work completed shall be conducted by the Landscape Architect and Owner's Representative for the purpose of initial acceptance. Any outstanding items revealed on inspection and identified on the punch list shall be corrected with two weeks. Initial acceptance shall be withheld until those items are completed. Acceptance can be on partially completed work. Warranty, for a period of one year, shall begin after landscape inspection and initial acceptance.
- B. Warrant in writing that all plant material, including groundcovers, placed on this Project will remain alive and be in healthy vigorous condition for a period of 1 year after completion and initial acceptance of entire project.
- C. During the warranty period replace, in accordance with the drawings and specifications, all plants that are in an unhealthy or unsightly condition, or more than 25% dead. Warrant all replacement trees for an additional one year period.
- D. Final Inspection and Acceptance: An inspection will be conducted with the Landscape Contractor, Landscape Architect and Owner at the end of the one year warranty period for purposes of Final Acceptance.
- E. Warranty shall not include damage or loss of plants due to vandalism, fire, severe winds, extreme cold, or negligence on the Owner's part.

## PART 2 - PRODUCTS

### 2.1 TREE MATERIAL

- A. General: Furnish nursery-grown trees complying with ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
  - 1. Root balls shall comply with ANSI 260.1 standards and shall meet sizes laid out in the ANSI 260.1 standards as well as being intact and undamaged when they arrive on the site. Trees that have deteriorated root balls will not be accepted.
- B. If formal arrangements or consecutive order of trees shown, select stock for uniform height and spread, and number label to assure symmetry in planting.

### 2.2 SHADE TREES

- A. Shade Trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, complying with ANSI Z60.1 for type of trees required.
  - 1. Provide balled and burlapped trees.
  - 2. All trees shall have their north side marked in the nursery prior to digging. Set trees in the hole with the marker facing north.

### 2.3 EVERGREENS

- A. Form and Size: Normal-quality, well-balanced, unsheared evergreens, of type, height, spread, and shape required.



2.4 TOPSOIL AND PLANT MIX: See Section 32 91 13 Soil Preparation

2.5 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight. Organic matter to be "Leaf Gro Compost" or approved equal.

2.6 FERTILIZER

- A. Apply fertilizers only if recommended by soil testing.
- B. All fertilizers shall be uniform in composition, free flowing and suitable for application with approved equipment. Applications shall be determined by soil test recommendations.
- C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium.
- D. Slow-Release Fertilizer: Granular or pellet fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium.
- E. Planting tablets: Tightly compressed chip type, long lasting, slow release, commercial grade planting fertilizer in tablet form.

2.7 MULCHES

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of shredded hardwood. Natural color only.

2.8 STAKES AND GUYS

- A. Upright and Guy Stakes: Rough-sawn, sound, new hardwood or pressure-preservative-treated softwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch by length indicated, pointed at one end.
- B. Guys and Tie Wires: No. 12 gauge galvanized wire.

**PART 3 - EXECUTION**

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing exterior plants from damage caused by planting operations.
- B. Lay out plants at locations directed by Landscape Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

### 3.2 TREE PIT EXCAVATION

- A. Tree Pits: Excavate circular pits with sides sloped inward, as shown on the Drawings. Trim base leaving center area raised slightly to support root ball and assist in drainage. Do not further disturb base. Scarify sides of plant pit smeared or smoothed during excavation.
  - 1. Excavate approximately three times as wide as ball diameter.
  - 2. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
  - 3. Do not excavate subgrades of adjacent paving, structures, hardscapes or other new or existing improvements.
- B. Subsoil and topsoil from excavations may be used as a component of the planting soil upon approval of the Landscape Architect.
- C. Notify Landscape Architect if unexpected rock, obstructions or impermeable soils detrimental to trees or shrubs are encountered in excavations. Notify Landscape Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

### 3.3 TREE PLANTING

- A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements. Do not use planting stock if root ball is cracked or broken before or during planting operation.
- B. Set plants to the elevations shown on the drawings. Place a maximum 2" soil on top of root ball. Set trees on compacted pads as shown. Use plant mix specified to backfill pit approximately 2/3 full. Water thoroughly before installing remainder of the plant mix to top of pit, eliminating all air pockets. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.
- C. Place planting tablets in each tree planting pit when pit is approximately one half filled, in amounts recommended in soils reports from soil testing laboratory. Place tablets beside the root ball about one inch from root tips.
- D. Cut ropes and strings from top of tree root balls after plant has been set. Remove burlap or cloth wrapping from around top half of balls, do not remove from under root balls. Do not turn under and bury any portion of burlap.
- E. Smooth planting areas to conform to the grades indicated after full settlement has occurred and mulch has been applied. Thoroughly water plants after mulching.

### 3.4 TREE PRUNING

- A. Prune, thin, and shape trees as only as directed by Landscape Architect.

### 3.5 SHRUB PLANTING

- A. Preparation of planting beds: Excavate entire planting bed to specified depths as shown on Drawings. Till subsurface to a depth of 6 inches. Place planting soil per specified depths, allowing for settlement.
- B. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in shrub planting beds.

- C. Mulch entire planting bed with mulch. Thoroughly water plants after mulching.

### 3.6 GUYING AND STAKING

- A. Stake trees as shown on drawings.

### 3.7 CLEANUP AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.
- B. Protect exterior plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

### 3.8 MAINTENANCE

- A. Contractor is responsible for the following maintenance period by pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, tightening and repairing stakes and guy supports, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray as required to keep trees and shrubs free of insects and disease.
  - 1. Maintenance Period: Until completion of building construction and initial acceptance of all plant material.
- B. Maintenance between initial acceptance and final acceptance shall be the responsibility of the Owner.

END OF SECTION 32 93 00

SECTION 330101  
REPAIRING BROKEN MAINS AND LATERALS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 DESCRIPTION

- A. Repair or replace all wastewater mains and service laterals, water mains and service lines, storm sewers, gas mains and service lines, and other utility lines which break or are damaged due to the contractor's construction activities.

1.3 SUBMITTALS

- A. Manufacturer's product data and installation instructions.

PART 2- PRODUCTS

2.1 WASTEWATER COUPLINGS

- A. Couplings as manufactured by Smith-Blair; Romac Industries, Inc; or JCM Industries.

2.2 WATER MAIN COUPLINGS

- A. Couplings as manufactured by Dresser Industries, Inc; Romac Industries, Inc; or JCM Industries.

2.3 WATER MAIN CLAMPS

- A. Clamps as manufactured by Dresser Industries, Inc.; Romac Industries, Inc; or JCM Industries.

PART 3- EXECUTION

3.1 GENERAL

- A. Replacing broken or damaged water or wastewater mains and laterals:
  - 1. Comply with ordinances or regulations or water or sewer authority having jurisdiction.
  - 2. If no ordinances or regulations exist, replace with same type, class, grade, or schedule or pipe or better.
- B. Replacing broken or damaged gas, electric, telephone, cable, or other utility lines:
  - 1. Comply with regulations of utility company.

3.2 INSTALLATION

- A. Install couplings and clamps in accordance with manufacturer's installation instructions.

END OF SECTION

SECTION 330130.72  
RELINING SEWERS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUBMITTALS

- A. Manufacturer's product data, video installation and installation instructions.

1.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Exercise care in transporting and handling to avoid damage.
- B. Store materials on site in enclosures or under protective coverings as recommended by manufacturer.
- C. Do not store materials directly on the ground.
- D. Keep interior of all pipe free from dirt or foreign material at all times.

PART 2 - PRODUCTS

2.1 BASIC MATERIALS

- A. The pipe shall be made from PVC compound meeting all the requirements for cell classification 12334 as defined in specification D1784 and with the following minimum physical properties.

Tensile Strength	Test Method D638	6,000 psi (41.4 MPa)
Tensile Module	Test Method D638	320,000 psi (2,206MPa)
Flexural Strength	Test Method D790	6,000 psi (31.3 MPa)
Flexural Modulus	Test Method D790	320,000 psi (2,206 MPa)
Heat Deflection Temperature Tested @ 264 psi (2MPa)	Test Method D648	115°F (46°C)

2.2 OTHER REQUIREMENTS

- A. Pipe Flattening - There shall be no evidence of splitting, cracking or breaking when the rounded pipe is tested according to section 11.3 of ASTM F1504.
- B. Pipe Impact Strength - The impact strength of rounded pipe shall not be less than the following values when tested in accordance with test method D2444 as referenced in ASTM F1504.

Pipe size, in. (mm)	Impact strength, ft-lb f (J)
6 (150)	210 (284)
8 (200)	210 (284)
10 (250)	220 (299)
12 (300)	220 (299)
15 (375)	220 (299)
18 (450)	220 (299)
24 (600)	220 (299)
30 (750)	220 (299)

2.3 PIPE STIFFNESS

- A. Values for pipe stiffness for the rounded pipe shall comply with the following values when tested in accordance with test method D2412 as referenced in ASTM F1504.

Pipe Size, in. (mm)	Pipe Stiffness, psi (kPa)
6 (150)	36 (250)
8 (200)	36 (250)
10 (250)	36 (250)
12 (300)	22 (153)
15 (375)	12 (83)
18 (450)	6 (41)
24 (600)	6 (41)
30 (750)	6 (41)

## 2.4 EXTRUSION QUALITY

- A. The extrusion quality of the pipe shall be evaluated by the following test methods:
1. Acetone Immersion: The pipe shall not flake or disintegrate when tested in accordance with test method D2152 as referenced in ASTM F1504.
  2. Heat Reversion: The extrusion quality of the pipe shall be estimated by heat reversion method in accordance with practice F1057 as referenced in ASTM F1504.
  3. Flexural Properties: The flexural strength and modulus of the pipe shall be tested in accordance with test method D790 as referenced in ASTM F1504.

## 2.5 DIMENSIONS

- A. Rounded Pipe Diameter: The average outside diameter of the formed pipe shall meet requirements in Table 3, +/- 1.0% when tested in accordance with test method D2122 as referenced in ASTM F1504.
- B. Rounded Pipe Wall Thickness: The wall thickness of the formed pipe shall not be less than the following values when tested in accordance with test method D2122 as referenced in ASTM F1504.

Nominal Outside Diameter, in. (mm)	Minimum Wall Thickness, in. (mm)
6 (150)	0.17 (4.3)
8 (200)	0.23 (5.8)
10 (250)	0.28 (7.3)
12 (300)	0.29 (7.4)
15 (375)	0.30 (7.6)
18 (450)	0.27 (6.8)
24 (600)	0.34 (8.7)
30 (750)	0.43 (10.8)

## 2.6 WORKMANSHIP, FINISH, APPEARANCE

- A. The rounded and folded pipes shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions, or other defects. The pipe shall be as uniform as commercially possible in color, opacity, density and other physical properties.

## 2.7 PRODUCT MARKING

- A. Pipe shall be clearly marked as follows at intervals of 5ft. (1.5m) or less:
- Manufacturer's name or trademark and code
  - Nominal outside diameter
  - The PVC cell classification, for example "12334"
  - The legend "DR XX FOLDED PVC PIPE"
  - The designation "Specification ASTM F1504"
  - Length marker and liner distance label, for example "100FT" ("30.5M")

## 2.8 PACKAGING

- A. The full length of the PVC pipe is coiled onto a reel in a continuous length for storage and shipment. The minimum diameter of the reel drum or core shall be 48in (1,219mm).

## 2.9 QUALITY ASSURANCE

- A. When the product is marked with ASTM F1504 designation, the manufacturer affirms that the product was manufactured, inspected, sampled and tested in accordance with the specification and has been found to meet the requirement of it.

## PART 3 - EXECUTION

### 3.1 PRE-INSTALLATION TV INSPECTION

- A. Contractor responsible for bypass flow as required.
- B. Prior to inspection, the pipeline is cleaned using a high-pressure water jet to remove any debris in the pipeline.
- C. Identify any conditions in the pipeline that could impede or prevent the proper installation of the liner.
- D. Provide a record of the pre-lined condition of the pipe.
- E. Accurately record the position of all service laterals.
- F. In the event of a discrepancy, immediately notify the Engineer and do not proceed with the installation of the lining system until resolved.

### 3.2 PRE-INSTALLATION PIPELINE PREPERATION

- A. Roots:
  - 1. Roots must be removed from the pipeline prior to installing the liner.
  - 2. Roots may be removed using a mechanical means such as chain flails.
- B. High level of groundwater infiltration:
  - 1. Large quantities of cold groundwater flowing into the pipeline can act as a heat sink and prevent the PVC liner material from reaching the temperature needed to properly form.
  - 2. Infiltration may be eliminated by chemically grouting or installing a patch prior to lining.
- C. Collapsed pipe:
  - 1. Collapsed pipe that reduces the inside circumference of the pipeline to less than the outside circumference of the pipe liner will not allow the liner to form properly. This condition is usually presented as a longitudinal rib after the liner is installed.
  - 2. To avoid ribs in the liner, section of pipeline containing collapsed pipe shall be point repaired prior to lining.
- D. Offset joints:
  - 1. Offset or dropped joints of more than one inch of the inside pipe diameter can cause ribs to form in the liner, similar to collapsed pipe.
  - 2. To avoid ribs in the liner, sections of pipeline containing offset joints shall be point repaired prior to lining.
- E. Protruding taps:
  - 1. Service taps that protrude into the pipeline more than 12.5% or one inch should be cut off using a chain flail or remotely controlled grinder.

### 3.3 LINER INSTALLATION

- A. Equipment setup:

1. Stage a steam boiler apparatus, flow-through plug and the coiled liner at the upstream structure. Stage a winch, flow-through plug and exhaust manifold at the downstream structure.
  2. Use a jet apparatus to run the winch cable from the downstream structure to the upstream structure.
- B. Heat coiled liner:
1. Drill holes through the end of the liner pipe and connect the winch cable.
  2. Enclose or cover the coiled liner and heat with steam at approximately 190°F. heating time will vary depending on ambient temperature, altitude and steam quality.
- C. Insert liner into host pipe:
1. When the liner is pliable, make a pulling nose by drilling holes perpendicularly through the free end of the folded liner, then weaving a cable or chain through the holes.
  2. Insert the liner into the host pipe by uncoiling the pipe reel (either mechanically or manually) from the upstream side, with assistance from the winch cable at the downstream side.
  3. Liner shall be inserted at a rate of 100 to 200 feet per minute. Maintain the upstream feed from the pipe reel to avoid stretching the pipe with the winch cable. Coordinate the speed at which the liner is inserted into the pipeline using two-way radio communication between upstream and downstream stations. Pull enough liner so that sufficient material is available at the downstream manhole station to allow for inserting the flow through plug.
- D. Process liner:
1. After the liner pipe has been inserted and plugged at the upstream station, allow for the liner pipe to relax for approximately five (5) minutes. The liner pipe relaxation is particularly important if the liner pipe has been stretched during the installation process, and may require more than the five (5) minutes in those cases.
  2. Insert a flow-through plug into the upstream end of the liner (the upstream end may be reheated in order to soften the material enough to insert the plug). Leave a "window" of pipeliner between the opening of the host pipe and the end of the plug to allow for observation of the liner as it is processed. Attach the steam hose to the upstream plug, and apply the steam at approximately 195°F through the liner. Heat and relax the liner until movement at the downstream station has stopped. Cover the downstream end with a tarp or similar cover to allow the steam flow to soften the material enough to insert the downstream flow-through plug. Connect the downstream flow-through plug to the exhaust manifold, and apply a small amount of backpressure (approximately 0.5 PSI) to the liner system. Do not close the exhaust plug valve. The steam temperature and pressure are monitored and controlled at the upstream and downstream process stations.
  3. Heating time is determined by the length and wall thickness of the liner. Additional heating time may be added by the installer if warranted by field conditions within the host pipe. As the liner is thoroughly heated, internal pressure is slightly increased to cause the liner to conform tightly to the host pipe. From 0.5 to 5 PSI of backpressure should be sufficient to form the liner in the host pipe. At the end of the heating time, switch from steam to compressed air. Maintain internal pressure until the exhaust air temperature has reached a predetermined temperature (usually 100°F. Water may be induced into the compressed air during the cooling process to reduce the cooling time.
  4. If the liner fails to install properly, the contractor shall remove the failed liner and replace with a new liner at no additional cost to the owner.

### 3.4 POST INSTALLATION TV INSPECTION

- A. After the liner has cooled, remove the flow-through plugs and inspect the liner using CCTV. Ensure that the liner has formed properly and that there are no defects in the liner.

### 3.5 REINSTATEMENT OF SERVICE CONNECTIONS



- A. Reconnect interior services using a remotely controlled robot cutter.
  - 1. In most cases the service connection is located by means of a pronounced dimple in the liner.
  - 2. When the dimple is not clearly visible, refer to the pre-installation inspection and the previously recorded position of all service connections.
  - 3. Use a brush or rasp-type bit to make service connection holes. Do not use a fluted-type or router bit.
  - 4. When reinstated, the hole for the connection must be smooth and conform to the inside shape of the old opening.
  - 5. The hole must be a maximum 105% and a minimum of 90% of the service pipe diameter.
  - 6. The ends of the liner are neatly trimmed leaving one to one and a half inches of liner extruding into the manhole.
- B. Reconnect exterior services through excavation.
  - 1. Excavate for each existing lateral at wye location.
  - 2. Cut and remove existing host pipe and appurtenances.
  - 3. Install LMT saddle onto new fold and form pipe.
  - 4. Run new 4" SDR 35 lateral from LMT saddle to edge of easement / right of way line and bed pipe and saddle accordingly.
  - 5. 4" lateral paid for under its respective line item.
  - 6. Provide suitable backfill material.

### 3.6 CONNECTION TO REPLACED MANHOLE

- A. Provide and install a 3' stub of SDR 35 pipe, as described in measurement and payment, from manhole to existing host pipe and connect using a shielded reinforced ferro.
- B. Run fold and form pipe through pipe stub into the manhole

### 3.7 CLEAN-UP

- A. The contractor shall restore all disturbed areas by the work equal or better at the satisfaction of the engineer and shall furnish all labor and material incidental to.

END OF SECTION

## SECTION 331116

### SITE WATER UTILITY DISTRIBUTION PIPING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUBMITTALS

- A. Manufacturer's product data and installation instructions.
- B. Certified pressure test reports.

##### 1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Exercise care in transporting and handling to avoid damage to the pipe.
- B. Keep interior of all pipe free from dirt or foreign material.
- C. Keep bottom tier of stacked pipe off ground on timbers, rails, or concrete.
- D. Store gaskets for mechanical and push-on joints in a cool location out of direct sunlight.

#### PART 2- PRODUCTS

##### 2.1 WATER MAIN - DUCTILE IRON

- A. Ductile iron pipe centrifugally cast in metal or sand-lined molds:
  - 1. AWWA C151 (ANSI A21.51).
  - 2. Joint type: Push-on joint.
  - 3. Laying length: 20 feet.
  - 4. Thickness or class: Class 52, unless otherwise noted on drawings.
- B. Flanged ductile iron pipe with threaded flanges:
  - 1. AWWA C115 (ANSI A21.15).
  - 2. Length: as shown on drawings.
  - 3. Thickness or class: Class 3.
  - 4. Working pressure: 250 PSI.
  - 5. Pipe barrel: AWWA C151.
  - 6. Bolt circle and bolt holes: ANSI B16.1, Class 125.
  - 7. Facing: Plain faced without projection or raised face.
  - 8. Bolt holes: Equally spaced and straddle centerline of pipe.
  - 9. Bolts: ANSI B18.2.1.
  - 10. Nuts: ANSI B18.2.2.
- C. Inside lining: Cement-mortar lining, AWWA C104 (ANSI A21.4), standard thickness.
- D. Outside coating: Bituminous coating approximately 1 mil. thick.
- E. Markings on pipe:
  - 1. Manufacturer's name.
  - 2. Weight.
  - 3. Length.
  - 4. Class or nominal thickness.
  - 5. Casting period.
  - 6. Year in which pipe was produced.
  - 7. Letter "DIP" or "DUCTILE" shall be case or stamped on pipe.

##### 2.2 RUBBER GASKETS AND LUBRICANT

- A. AWWA C111 (ANSI A21.11).

## PART 3- EXECUTION

### 3.1 INSPECTION

- A. Examine all pipe for cracks and other defects while pipe is suspended above trench, immediately before installation. Defective material will be immediately removed from the job site.

### 3.2 CONNECTION STYLES

- A. Unless otherwise indicated on drawings, push-on joints shall be used for all buried applications and flanged joints shall be used for all non-buried applications.

### 3.3 ALIGNMENT AND GRADE

- A. As shown on drawings.
- B. Unforeseen obstructions: When obstructions that are not shown on drawings are encountered during progress of work and interfere so that an alteration of drawings is required, owner will alter drawings or order a deviation in line and grade or arrange for removal, relocations, or reconstruction of obstructions.
- C. Clearance: Adjust alignment and grade as necessary when crossing existing pipelines or structures, with approval of owner, to provide clearance as required by federal, state or local regulations or as deemed necessary by owner to prevent future damage or contamination of either structure.
- D. Minimum cover over pipe: 4'-0" unless otherwise shown on drawings or modified due to field conditions.
- E. Contractor will construct water lines on a level or uphill gradient. This will require additional excavation depth in locations to avoid highpoints at which air could accumulate. If contractor varies from plan depth and creates high points in the main line, contractor may need to install additional air release/air valve assemblies and manholes as per Engineer's request and at the contractor's expense.

### 3.4 INSTALLATION

- A. Install pipe in accordance with manufacturer's instruction and construction details.
- B. Lower pipe into trench so as to prevent damage to water main material and protective coatings and linings.
  - 1. Do not drop or dump pipe into trench.
- C. Dewater trench prior to installation.
  - 1. Dewatering to be in accordance with acceptable erosion and sedimentation measures.
- D. Cleaning pipe:
  - 1. Remove all lumps, blisters and excess coating from socket and plain ends of each pipe.
  - 2. Remove all dirt, sand, grit or any other foreign material from outside of plain end and inside of bell before laying pipe.
- E. Pipe placement:
  - 1. Prevent foreign material from entering pipe while it is being placed in trench.
  - 2. Do not place debris, tools, clothing or other material in pipe during laying operations.
  - 3. Assemble joint as each length of pipe is placed.
  - 4. Place pipe to correct line and grade.
  - 5. Secure pipe in place with approved backfill material.
- F. Direction of placement: Bell ends facing direction of laying.
  - 1. Pipe laid on 10 percent of greater grade: Begin laying pipe at bottom of grade and proceed upward with bell ends of pipe upgrade.
- G. Pipe plugs:
  - 1. Pipe laying not in progress: Close open ends of pipe with watertight plug.

2. Keep plug in place until trench is pumped dry.

### 3.5 PUSH-ON JOINT ASSEMBLY

- A. Clean the groove and bell socket.
- B. Insert rubber gasket in gasket recess of bell socket.
- C. Apply lubricant in accordance with manufacturer's recommendations.
  1. Gasket lubricant supplied by pipe manufacturer for potable water.
- D. Push plain end of pipe into the bell.
- E. Complete joint using forked tool, jack, lever puller or other device approved by owner.
- F. Pipe not furnished with depth mark: Mark before assembly to assure that spigot end is inserted full depth of joint.
- G. Make deflection after joint is assembled.
  1. Maximum deflection is in accordance with manufacturer's recommendations.

### 3.6 PIPE CUTTING

- A. Cut pipe at right angles to pipe axis.
- B. Cut using abrasive pipe saw, rotary wheel cutter, guillotine pipe saw, milling wheel saw, or oxyacetylene torch.
- C. Bevel cut end of pipe with suitable file, pipe lathe, or abrasive disc.
- D. Do not damage cement-mortar lining in ductile iron pipe.

### 3.7 ELECTRICAL CONDUCTIVITY

- A. If electrical conductivity is required provide as follows:
  1. Cable:
    - a. Material: No. 4 soft annealed 61 strand flexible copper cable.
      1. Cable to be attached to pipe (or fitting, or valve) by "Caldweld" or equal, length as required. Surface to be welded shall be clean and prepared in accordance with the weld manufacturer's instructions and be a type recommended by the same for the same for the condition encountered.
  2. Brass wedge.
    - a. Insert wedge between bell of one pipe and end of other pipe after push-on joint assembly has been completed.

### 3.8 WATER MAINS NEAR SANITARY SEWERS

- A. Horizontal separation:
  1. Place water mains at least 10 feet from existing or proposed sanitary sewers.
  2. Conditions prevent separation of 10 feet:
    - a. Lay water main in separate trench from sewer.
    - b. Lay water main in same trench with sewer with water main located at one side on a bench of undisturbed earth.
    - c. Elevation of crown of sewer at least 18 inches below invert of water main for either case.
  3. Conditions prevent separation of 18 inches: Relocate water main to provide separation or reconstruct water main with mechanical joint pipe for a distance of 10 feet on each side of sewer.
    - a. Center full length of pipe over sewer so that both joints are as far from sewer as possible.
- B. Conditions prevent both horizontal and vertical separation: Concrete encase water main for a distance as required by the PaDEP.

### 3.9 TESTING

- A. Conduct pressure/leakage testing of water mains: Section 331310.
- B. Disinfect water mains: Section 331300.

END OF SECTION

## SECTION 331200

### WATER UTILITY DISTRIBUTION EQUIPMENT

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUBMITTALS

- A. Manufacturer's product data and installation instructions.
- B. Statement of net weight of each size of fitting furnished.
- C. Shop drawings:
  - 1. Dimensions.
  - 2. Construct details.
  - 3. Materials of construction.

##### 1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Exercise care in transporting and handling to avoid damage.
- B. Examine all fittings and accessories at point of delivery and reject defective material.
- C. Store fittings and accessories in area protected from weather.
- D. Do not store materials directly on ground.
- E. Keep interior of all fittings free from dirt or foreign materials.

#### PART 2- PRODUCTS

##### 2.1 WATER MAIN FITTINGS

- A. AWWA C153 - compact fittings (Bends, tees and crosses, wyes, base bends, base trees, reducers, tapped tees, offsets, sleeves, caps and plugs and connecting pieces).
- B. Fittings shall be cast from ductile iron.
- C. Mechanic joint end connection: Includes glands, gaskets and bolts.
  - 1. AWWA C153 (ANSI 21.11).
  - 2. Gland: Gray iron, ANSI 21.11.
  - 3. Bolts and gaskets: ANSI 21.11.
- D. Flanged joint end connection: Includes gaskets and bolts.
  - 1. Bolts circle and bolt holes: ANSI B16.1, Class 125.
  - 2. Facing: Plain faced without projection or raised face.
  - 3. Bolt holes: Equally spaced and straddle centerline of fitting.
  - 4. Bolts: ANSI B18.2.1.
  - 5. Nuts: ANSI B18.2.2.
- E. Working pressure: 250 psi.
- F. Outside coating: Bituminous coating approximately 1 mil thick.
- G. Inside coating: Cement-mortar lining, ANSI A21.4 (AWWA C104), standard thickness.
- H. Markings on fittings:
  - 1. Manufacturer's identification.
  - 2. Pressure rating.
  - 3. Nominal diameters of openings.
  - 4. Number of degrees or fractions of the circle on all bends.
  - 5. Ductile iron fittings shall have the letters "DI" or "Ductile" cast on them.

#### PART 3- EXECUTION

### 3.1 INSPECTION

- A. Inspect fittings for defects in workmanship and materials.

### 3.2 INSTALLATION

- A. Unless otherwise shown on drawings, mechanical joint fittings shall be used for all buried applications and flanged joint fittings shall be used for all non-buried applications.
- B. Install fittings in accordance with manufacturer's instructions and thrust restraint detail.
- C. Locate as shown on drawings.
- D. Thoroughly clean fittings to remove loose rust or foreign material just prior to assembly.
- E. Mechanical joint fittings:
  - 1. Connecting mechanical joint fittings to aged existing cast iron pipe: Measure outside diameter of aged pipe prior to cutting.
  - 2. Provide adequate anchorage against thrust restraint where abrupt change in direction and dead ends occur.
  - 3. Keep joint straight during assembly.
  - 4. Make deflection after joint assembly but before tightening bolts.
  - 5. Align bolt holes and insert bolts, with bolt holes behind bell flange and tighten opposite nuts to keep gland square with socket.
- F. Flanged fittings:
  - 1. Flanged faces should bear uniformly on the gasket and bolts should be tightened uniformly.
  - 2. Anchor, support or restrain fittings as shown on drawings to prevent bending or torsional strains from being applied to cast flanges or flanged fittings.
- G. 90° Fittings:
  - 1. Use of 90° fittings are prohibited unless otherwise approved by Engineer.

END OF SECTION

SECTION 331210  
COUPLINGS AND ADAPTERS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUBMITTALS

- A. Manufacturer's product data and installation instructions.

PART 2- PRODUCTS

2.1 BASIS OF DESIGN

- A. Products listed are Basis of Design. "Or Equal" substitutions may be submitted but must be approved by the Professional if proven to be equal.

2.2 COUPLINGS

- A. Manufactured by Dresser Industries, Inc.; Romac Industries, Inc; or JCM Industries.
- B. Sizes as shown on drawings.
- C. Gasketed, sleeve-type, with diameter to properly fit pipe.
- D. Coupling shall consist of:
  - 1. Steel or cast iron middle ring or thickness and length specified.
  - 2. One or two steel or cast iron followers as required.
  - 3. Two rubber-compounded wedge section gaskets and sufficient track-head steel bolts to properly compress gaskets.

2.3 ADAPTERS

- A. As manufactured by EBAA Iron "Megalug"; Romac Industries, Inc; or Dresser Industries, Inc.
- B. Size: As shown on drawings.
- C. Gasketed, sleeve-type, with diameter to properly fit pipe.
- D. Adapter shall consist of cast iron adapter of thickness and length specified with rubber-compounded wedge section gaskets and sufficient track-head steel bolts to properly compress gaskets.

PART 3- EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's installation instructions.
- B. Assemble couplings or adapters to insure permanently tight joints under all reasonable conditions of expansion, contraction, shifting and settlement.
- C. Provide tie rod axial restraint for all flanged adapter application.
- D. Contractor shall verify size of all couplings or adapters before ordering.

END OF SECTION



SECTION 331212  
THRUST RESTRAINTS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 DESCRIPTION

- A. Install thrust restraints for the purpose of resisting axial thrusts. Size restraints in accordance with page 2 of this section.

PART 2- PRODUCTS

2.1 BASIS OF DESIGN

- A. Products listed are Basis of Design. "Or Equal" substitutions may be submitted but must be approved by the Professional if proven to be equal.

2.2 CONCRETE

- A. High early strength concrete: 3750 psi after 28 days.

2.3 TIE RODS

- A. High strength low alloy steel.
- B. 3/4 inch.
- C. Threads: ANSI B1.2.
- D. Gray iron nuts, ANSI 21.11.
- E. Asphaltum varnish or bituminous coating in field.

2.4 DUC-LUGS

- A. Duc-lugs for four inch to 16 inch mechanical joint pipe, valves, fire hydrants and fittings by EBAA Iron "Megalug"; Romac Industries, Inc; or Dresser Industries, Inc..

PART 3- EXECUTION

3.1 LOCATE THRUST RESTRAINTS AT THE FOLLOWING

- A. Change in pipeline direction: Tees, wyes, bends, and crosses.
- B. Change in pipeline size: Reducers.
- C. Dead end.
- D. Valves.
- E. Hydrants.
- F. Flanged adapters.

3.2 INSTALLATION

- A. Fire hydrant assemblies: Brace bowl of hydrant against a sufficient area of unexcavated earth at the end of the trench with concrete backing or tie to the pipe with metal tie rods.
- B. Fittings:

1. Provide with reaction backing, or suitably restrain by attaching metal rods.
2. Place concrete between solid ground and fitting to be anchored.
3. Minimum area of bearing against undisturbed earth: As shown on page 02665-3.
4. Minimum area of bearing on the fitting: Diameter of pipe times 8 inches.
5. Locate concrete so as to contain the resultant thrust force and so that the pipe and fitting joints will be accessible for repair.

PIPE INSIDE DIA (IN)	AREA (SQ IN)	FORCES (Pounds)					BEARING AREA OF BLOCK (Square Feet)				
		TOTAL THRUST FORCE	RESULTANT THRUST FORCE				A	B	C	D	E
			90E	45E	222E	113E	PLUG TEE VALVE	90E	45E	222 E	113E
2	3	675	954	517	263	150	-	-	-	-	-
3	7	1,580	2,230	1,210	614	350	-	-	-	-	-
4	13	2,930	4,140	2,240	1,140	650	0.7	1.0	0.6	-	-
6	28	6,300	8,990	4,820	2,460	1,400	1.6	2.2	1.2	0.6	-
8	50	11,300	15,900	8,620	4,390	2,500	2.8	4.0	2.2	1.1	0.6
10	79	17,800	25,100	13,600	6,930	3,950	4.4	6.3	3.4	1.7	1.0
12	113	25,400	36,000	19,500	9,920	5,650	6.4	9.0	4.9	2.5	1.4
14	154	34,600	49,000	26,500	13,500	7,700	8.6	12.2	6.6	3.4	1.9
16	201	45,200	64,000	34,600	17,600	10,000	11.3	16.0	8.6	4.4	2.5

\*See Construction Details

If Concrete Thrust Blocks are used for thrust restraint, all valves, tees, wyes, crosses, plugs, reducers and beds of 10E or more shall be blocked against firm undisturbed earth.

Earth pressure in the above table is estimated to be 2 tons per square foot. Area of the block must be increased proportionally if the earth encountered will not withstand this pressure.

This table is based on 225 psi test pressure.

Reducer Thrust Force and Block Area Determined as follows: i.e. 16 x 10 Reducer Thrust Force = 45,200 - 17,800 = 27,400 Pounds; Block Area 11.3-4.4 = 6.9 Square Feet (A<sub>L</sub>-A<sub>S</sub>)

Allowable Thrust Resistance Per 3/4" tie Rod = 8,800 Pounds. Minimum 2 Tie Rods Per Side of Fitting.

END OF SECTION

SECTION 331213  
WATER SERVICE CONNECTIONS

PART 1- GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUBMITTALS

- A. Manufacturer's literature, illustrations and installation instructions.
- B. Weights: Statement of net assemblies weight of each size of tapping sleeve and valve furnished.
- C. Shop drawings:
  - 1. Dimensions.
  - 2. Construction details.
  - 3. Materials.
- D. Maintenance data:
  - 1. Maintenance instructions.
  - 2. Parts lists.

1.3 PRODUCT DELIVER, STORAGE AND HANDLING

- A. Prepare valves and accessories for shipment according to AWWA C509 Section 7.
- B. Seal valve ends to prevent entry of foreign material into valve body.
- C. Box, crate, completely enclose, and protect valves and accessories from accumulations of foreign material.
- D. Store valves and accessories in area protected from weather, moisture or possible damage.
- E. Do not store materials directly on ground.
- F. Handle items to prevent damage to interior or exterior surfaces.

PART 2- PRODUCTS

2.1 BASIS OF DESIGN

- A. Products listed are Basis of Design. "Or Equal" substitutions may be submitted but must be approved by the Professional if proven to be equal.

2.2 MECHANICAL JOINT TAPPING SLEEVES

- A. Four inch through 24 inch cast iron or ductile iron with duck-tipped end gaskets, 200 pounds per square inch working pressure by Mueller, Romac, or Smith Blair.

2.3 TAPPING VALVES

- A. AWWA C509.
- B. Sizes: Four inch through twelve inch.
- C. Iron body with modified wedge disc.
- D. Stem construction: Non-rising.
- E. Stem seals: O-ring seals above and below thrust collar.
- F. Machine groove in stem directly beneath operating nut.
- G. Resilient rubber seat ring: Field Replaceable.
- H. Inside surface: Epoxy coated.
- I. End connections:

1. Mechanical joint, AWWA C153.
  2. Flanged joint, ANSI B16.1.
- J. Wrench nuts:
1. Top: 1-15/16 inch square.
  2. Base: 2-inch square.
  3. Height: 1-3/4 inch.
- K. Operators:
1. Direction of rotation to open: Left (counter-clockwise) with operator marked to show direction to open.
  2. Wrench nuts without extension stems.

## PART 3- EXECUTION

### 3.1 INSPECTION PRIOR TO INSTALLATION

- A. Verify:
1. Compliance with specifications.
  2. Direction of opening.
  3. Size and shape of operating nut.
  4. Number of turns.
  5. Type of end connections.
- B. Inspect for damage in shipment.
- C. Cycle valve through one complete opening-and-closing cycle to verify operation.

### 3.2 INSTALLATION

- A. Install valves and accessories in accordance with manufacturer's instructions.
- B. Locate valves as shown on drawings.
- C. Install valves in the closed position.

### 3.3 ADJUSTMENT

- A. Check and adjust valves and accessories for smooth operation.

END OF SECTION

## SECTION 331216

### WATER UTILITY DISTRIBUTION VALVES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUBMITTALS

- A. Manufacturer's product data and installation instructions.
- B. Shop drawings:
  - 1. Dimensions.
  - 2. Construction details.
  - 3. Materials.
- C. Maintenance data:
  - 1. Maintenance instructions.
  - 2. Parts lists.

##### 1.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves and accessories for shipment according to AWWA C509 Section 7.
- B. Seal valve end to prevent entry of foreign material into valve body.
- C. Box, crate, completely enclose, and protect valves and accessories from accumulations of foreign material.
- D. Store valves and accessories in area protected from weather, moisture, or possible damage.

#### PART 2- PRODUCTS

##### 2.1 BASIS OF DESIGN

- A. Products listed are Basis of Design. "Or Equal" substitutions may be submitted but must be approved by the Professional if proven to be equal.

##### 2.2 GATE VALVES

- A. Mueller; Clow Valve, Co.; Kennedy Valve
- B. AWWA C509.
- C. Sizes: Four inch through eight inch.
- D. Iron body with modified wedge disc.
- E. Stem construction: Non-rising. Stems to be extended to within 4'-0" of final grade.
- F. Stem seals: O-ring seals above and below thrust collar.
- G. Machine groove in stem directly beneath operating nut.
- H. Resilient rubber seat ring: Field Replaceable.
- I. Inside surface: Epoxy coated.
- J. End connections:
  - 1. Mechanical joint, AWWA C111.
  - 2. Flanged joint, ANSI B16.1.
- K. Wrench nuts:
  - 1. Top: 1-15/16 inch square.
  - 2. Base: 2-inch square.
  - 3. Height 1-3/4 inch.
- L. Operators:

1. Direction of rotation to open: Left (counter-clockwise) with operator marked to show direction to open.
2. Handwheels: Valves in exposed accessible locations.
3. Wrench nuts without extension stems.

### 2.3 AWWA GATE VALVES

- A. AWWA C500.
- B. Sizes: Two inch and three inch.
- C. Iron body, bronze mounted, double disc, parallel seat type.
- D. Stem construction: Non-rising.
- E. Stem seals: O-ring seals above and below thrust collar.
- F. Asphalt varnish finish on iron parts.
- G. End constructions:
  1. Mechanical joint, AWWA C111.
  2. Flanged joint, ANSI B16.1.
- H. Operators:
  1. Direction of rotation to open: Left (counter-clockwise) with operator marked to show direction to open.
  2. Handwheels: Valves in exposed accessible locations.

## PART 3- EXECUTION

### 3.1 INSPECTION PRIOR TO INSTALLATION

- A. Verify:
  1. Compliance with specifications.
  2. Direction of opening.
  3. Size and shape of operating nut.
  4. Number of turns.
  5. Type of end connections.
- B. Inspect for damage in shipment.
- C. Cycle valve through one complete opening-and-closing cycle to verify operation.

### 3.2 INSTALLATION

- A. Unless otherwise shown on drawings, mechanical joint and connections shall be used for all buried applications and flanged joint end connections shall be used for all non-buried applications.
- B. Install valves and accessories in accordance with manufacturer's instructions.
- C. Locate valves as shown on drawings.
- D. Install valves in the closed position.

### 3.3 ADJUSTMENT

- A. Check and adjust valves and accessories for smooth operation.

END OF SECTION

SECTION 331218  
VALVE BOXES AND COVERS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUBMITTALS

- A. Manufacturer's product data and installation instructions.

PART 2- PRODUCTS

2.1 BASIS OF DESIGN

- A. Products listed are Basis of Design. "Or Equal" substitutions may be submitted but must be approved by the Professional if proven to be equal.

2.2 VALVE BOXES

- A. Screw type, 2 piece: Tyler, Mueller, or Trumbull.
- B. Shaft: 5-1/4 inch.
- C. Extension range to be determined in field by contractor.
- D. Cast iron construction.

2.3 VALVE BOX COVERS

- A. Type: Tyler, Mueller, or Trumbull drop lid or equal.
- B. Markings:
  - 1. Water application: Embossed with the word "water".
  - 2. Sewer application: Unmarked.
- C. Indents to facilitate removal.
- D. Cast iron construction.

PART 3- EXECUTION

3.1 INSTALLATION

- A. Install valve box so as not to transmit shock or stress to valve.
- B. Center valve box over operating nut of valve with box cover flush with surface of finished area.
- C. Set valve box plumb.

END OF SECTION

SECTION 331220  
FIRE HYDRANT ASSEMBLY

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUBMITTALS

- A. Manufacturer's product data and installation instructions.
- B. Shop drawings:
  - 1. Dimensions.
  - 2. Construction details.
  - 3. Materials.
- C. Maintenance data:
  - 1. Maintenance instructions.
  - 2. Parts lists.

1.3 PRODUCTS DELIVERY, STORAGE AND HANDLING

- A. Prepare hydrant and accessories for shipment according to AWWA C502, Section 6.
- B. Seal inlet shoe connection end to prevent entry of foreign material into hydrant.
- C. Store hydrant and appurtenances in area protected from weather elements.
- D. Handle materials to prevent damage to interior or exterior surfaces.

PART 2- PRODUCTS

2.1 BASIS OF DESIGN

- A. Products listed are Basis of Design. "Or Equal" substitutions may be submitted but must be approved by the Professional if proven to be equal.

2.2 DRY-BARREL FIRE HYDRANT ASSEMBLY

- A. AWWA C502.
- B. Hydrant to match existing hydrants; or American Flow Control B-62-B, Kennedy, or Mueller.
- C. Size of main valve opening: 5-1/5"
- D. Hose nozzles: Two 2-1/2"
  - 1. Contractor to verify thread dimensions with local fire company prior to purchasing.
- E. Pumper nozzle: One 4".
  - 1. Contractor to verify thread dimensions with local fire company prior to purchasing.
- F. Minimum depth to bury (Distance from ground to top of connection pipe):
  - 1. Hydrants in new water main construction: 4'-0".
  - 2. New hydrants in existing system: Depth of bury to be determined in field by contractor.
- G. Type of inlet connection: Mechanical joint.
- H. Size of inlet connection: 6".
- I. Inlet connection: Epoxy coated.
- J. Size and shape of operating nut: National standard 1-1/2" pentagon.
- K. Direction of opening: Left (counter-clockwise).
- L. Color: To match existing hydrants or by owner.
- M. Drain valve: Positive automatic.



## 2.3 MISCELLANEOUS APPURTENANCES

- A. 6" resilient seat gate valve with valve box and cover.
- B. Hydrant lateral pipe:
  - 1. Installation of hydrant assembly on new system: Similar material and class as water main.
  - 2. Installation of hydrant assembly on existing system: As shown on drawings.
  - 3. Length of pipe: As required to meet field conditions.
- C. Tie rods or high early strength cement concrete thrust block.
- D. Two 4"x8"x16" concrete solids.
- E. PENNDOT 2B stone for drainage pit.
- F. Hydrant tee and other fittings required will be paid for under fittings.

## PART 3- EXECUTION

### 3.1 INSPECTION

- A. Prior to installation, inspect all hydrants for:
  - 1. Direction of opening.
  - 2. Nozzle threading.
  - 3. Operating-nut and cap-nut dimensions.
  - 4. Tightness of pressure-containing bolting.
  - 5. Cleanliness of inlet elbow.
  - 6. Handling damage.
  - 7. Cracks.

### 3.2 INSTALLATION

- A. Install hydrant assembly in accordance with manufacturer's instructions and fire hydrant assembly detail.
- B. Location: Locate hydrants as shown on drawings.
- C. Hydrants having two-hose nozzles at 90° apart: Set with each nozzle facing the curb or street at an angle at 45°.
- D. Set hydrant to established grade.
- E. Hydrant set in pervious soil:
  - 1. Provide drainage at base of hydrant by placing coarse gravel or crushed stone mixed with coarse sand from bottom of trench to at least 6" above waste opening in hydrant.
  - 2. Drainage pit diameter: Minimum of 2' greater than hydrant barrel.
- F. Hydrant set in clay or other impervious soil:
  - 1. Excavate drainage pit below hydrant and fill with coarse gravel or crushed stone mixed with coarse sand, under and around the elbow of hydrant to a level 6" above waste opening.
  - 2. Drainage pit: 2' Ø x 3' deep.
- G. Installing hydrant behind curb:
  - 1. Distance from pumper nozzle cap to gutter face of curb:
    - a. Minimum: 6"
    - b. Maximum: 12"
- H. Installing hydrant in lawn space between curb and sidewalk or between sidewalk and property line: Minimum 6" between hydrant or nozzle cap and sidewalk.

### 3.3 ADJUSTMENTS

- A. Check and adjust fire hydrant assembly for smooth operation.

END OF SECTION

## SECTION 331300

### DISINFECTING OF WATER UTILITY DISTRIBUTION

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUBMITTALS

- A. Contractor's method of disinfection.
- B. Chlorine residual field test results.

##### 1.3 QUALITY CONTROL

- A. Water utilized for testing shall be potable.
- B. Hypochlorites supplied shall contain no soluble mineral or organic substances in quantities that would be deleterious or injurious to anyone consuming any water treated with acceptable quantities of hypochlorite.

##### 1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Prepare hypochlorites for shipment according to AWWA B300, Section 3.
- B. Prepare liquid chlorine for shipment according to AWWA B301, Section 3.
- C. Store hypochlorites in a cool, dry, dark place away from flammable materials.

#### PART 2- PRODUCTS

##### 2.1 HYPOCHLORITES

- A. AWWA B300.
- B. Calcium hypochlorite granules:
  - 1. Substantially free from lumps.
  - 2. Available chlorine by weight when shipped: Not less than 65 percent.
- C. Calcium hypochlorite tablets:
  - 1. Uniform in shape.
  - 2. Weight of tablets: Not vary more than five percent from average value stated on label.
  - 3. Available chlorine by weight when shipped: Not less than 65 percent.
- D. Sodium hypochlorite solution:
  - 1. Clear liquid.
  - 2. Insoluble material by weight: Not more than 0.15 percent.
  - 3. Available chlorine: Not less than 100 g/L (ten trade percent).

##### 2.2 LIQUID CHLORINE

- A. AWWA B301.
- B. 99.5 percent pure by volume as obtained from vaporized liquid chlorine.

#### PART 3- EXECUTION

##### 3.1 PREPARATION

- A. Flush main prior to disinfection:
  - 1. Exception: When calcium hypochlorite tablets are used.
  - 2. Minimum flushing velocity: 2.5 feet per second.
  - 3. Discharge points: Capable of properly flushing entire system.

### 3.2 TESTING

- A. Allow water from existing distribution system or other approved source to flow at constant rate into pipeline.
- B. Feed dose of chlorine to water at constant, measured rate.
- C. Apply chlorine in accordance with manufacturer's instructions.
- D. Proportion the two rates so that the chlorine concentration in the water is maintained at a minimum of 50 mg/L available chlorine.
  - 1. To assure concentration is maintained, measure chlorine residual at regular intervals in accordance with procedures described in standard methods.
- E. During the application of chlorine manipulate valves to prevent treatment dosage from flowing back into the line supplying the water.
- F. Chlorine application shall not cease until the entire main is filled with chlorine solution.
- G. Minimum time for chlorinated water to remain in main: 24 hours.
- H. Operate all valves and hydrants in section being tested during test period in order to disinfect the appurtenances.
- I. Available chlorine throughout length of main at end of 24 hour test period: Not less than 25 mg/L.
- J. Flush heavily chlorinated water from main after 24 hour retention period.
  - 1. Chlorine concentration in water: No higher than that prevailing in the source or less than 1 mg/L.
    - a. Measure chlorine residual to ascertain that heavily chlorinated water has been removed from the pipeline.
- K. A final disinfection of water main is required after any main repair.

### 3.3 FIELD QUALITY CONTROL

- A. After final flush, and before main is placed in service, collect water samples from representative points along the main and field test for chlorine residual.
  - 1. Chlorine residual shall be within 50 percent of the chlorine residual prevailing in the source.
- B. If initial disinfection fails to provide satisfactory samples, repeat disinfection until satisfactory samples have been obtained.

### 3.4 EXERCISE OF CAUTION

- A. Exercise caution when using granular calcium hypochlorite for disinfection of system when solvent weld PVC pipe is used in system. The introduction of granular calcium hypochlorite with PVC solvent welding materials may result in violent chemical reaction, if a water solution is not used.

END OF SECTION

## SECTION 331310

### WATER DISTRIBUTION SYSTEM - PRESSURE/LEAKAGE TESTING

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 TESTING CONSTRAINTS

- A. Allowable leakage: 10 gallons per inch of pipe diameter per mile of pipe per 24 hours.

##### 1.3 QUALITY CONTROL

- A. Water utilized for testing shall be potable. Source of water is subject to owner approval.

#### PART 2- PRODUCTS

##### 2.1 MATERIALS

- A. Water for pressure/leakage test:
  - 1. Supplied by owner.
  - 2. Transported by contractor.
  - 3. Owner will establish the amount of water supplied and hours for supplying it.
- B. Pump, pipe connection, electrical generator, and all necessary apparatus for testing shall be furnished by contractor.
- C. Corporation stops and saddles or other means of connecting test apparatus and expelling air from system shall provide service rating at least equivalent to water main which they are tapping.
- D. Means of measuring total leakage:
  - 1. Open container such as 55-gallon barrel.
  - 2. Metering device not acceptable.

#### PART 3- EXECUTION

##### 3.1 PREPARATION

- A. If contractor elects to test water mains prior to disinfection and a public water supply is used as a source of water, place a 3/4 inch corporation stop in the new water main, a 3/4 inch corporation stop in the existing water main, and a backflow preventor in the 3/4 inch line between the two corporation stops. No other physical connection between the undisinfected main and public water supply is permissible until disinfection of the new main is complete.
- B. Location of test to be determined by owner.
- C. Slowly fill section of main with water and expel air from pipe.
- D. Install corporation stops at high points or dead ends, if permanent air vents or blowoffs are not located at such points so that air can be expelled as main is filled with water.
- E. Close corporation stops after all air is expelled.

##### 3.2 TESTING

- A. Conduct pressure/leakage test of newly laid water mains, valves, fittings, hydrants, and service lines to curb stop.
- B. Test duration: Two hours.

- C. Test pressure: 150 pounds per square inch.
  - 1. Based on elevation of lowest point of line, or section under test, and corrected to elevation of test gage.
  - 2. Allowable pressure drop during test: Five pounds per square inch. Re-pump during test to maintain the specified pressure within the specified tolerance.
  - 3. Pressure at conclusion of testing: Equal to or greater than pressure at beginning of testing.
- D. Leakage: Quantity of water supplied into main and appurtenances, or any valve section thereof, to maintain specified test pressure after air in main has been expelled and main filled with water.

### 3.3 FIELD QUALITY CONTROL

- A. Do not test any section of main which is provided with concrete thrust blocks until at least five days have elapsed after concrete was installed.
- B. If high-early-strength concrete is used in thrust blocks: Do not test until at least two days have elapsed.
- C. Testing of pipe discloses leakage greater than allowable leakage:
  - 1. Contractor shall, at his own expense, locate and repair defective pipe or joints until, upon retesting, leakage is within allowable leakage.
  - 2. All repairs to water mains or appurtenances shall be made with new material.
  - 3. No caulking of threads, cracks, or holes will be accepted.
  - 4. Replacement of materials shall be with the same material and thickness as the defective unit.

END OF SECTION

SECTION 333100  
SANITARY UTILITY SEWERAGE PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUBMITTALS

- A. Manufacturer's product data and installation instructions.

1.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Exercise care in transporting and handling to avoid damage.
- B. Store materials on site in enclosures or under protective coverings.
- C. Materials are not to be stored directly on the ground.
- D. Only stack pipe to the height recommended by the manufacturer.
- E. Stack bells in opposing directions on alternate rows so the bells do not rest on each other.
- F. Keep interior of pipe free from dirt or foreign material.
- G. Store gaskets for push on joints in a cool location and out of direct sunlight.
- H. Do not store materials in State road Right-of-Way or in clear zones as per PennDOT Publication 203.

PART 2- PRODUCTS

2.1 GRAVITY WASTEWATER PIPE - PVC

- A. PVC gravity wastewater pipe and fittings:
  - 1. ASTM D3034, Type PSM PVC wastewater pipe and fittings, SDR 35.
  - 2. Pipe: PVC plastic having a cell classification of 12454-B or 12454-C or 13364-B (with a minimum tensile modulus of 500,000 psi), ASTM D1784.
  - 3. Push-on joint.
  - 4. Laying length: 13 feet.
- B. Piping shall be identified with the following:
  - 1. Manufacturer's name or trademark.
  - 2. Nominal size.
  - 3. PVC cell classification.
  - 4. PSM.
  - 5. SDR-35.
  - 6. PVC sewer pipe.
  - 7. ASTM D3034.
  - 8. Code number.

2.2 GASKETS AND LUBRICANTS

- A. Gaskets and lubricants shall be made from materials that are compatible with plastic material and with each other when used together.
- B. Elastomeric gaskets: ASTM F477.

2.3 ELEVATIONS

- A. Contractor shall use a laser for setting pipe grades.

## PART 3- EXECUTION

### 3.1 INSPECTION

- A. Examine all pipe for cracks and other defects. Defective pipe shall be immediately removed from the job site.

### 3.2 ALIGNMENT AND GRADE

- A. Grades are shown on the profile and are the inner side of the invert.
- B. When obstructions that are not shown on drawings are encountered during construction and interfere so that an alteration of drawings is required, the owner will alter the drawings or order a deviation in line and grade or arrange for removal, relocation, or reconstruction of obstructions.
- C. Adjust alignments and grades as required and with owner approval when crossing existing pipelines or structures to provide the clearance as required by federal, state or local regulations or as determined by owner to prevent future damage or contamination of either structure.
  - 1. Where clearance is less than 6 inches, the owner shall be notified for a decision regarding realignment or adjustment of grade.
- D. Pipe shall be bedded to line and grade with uniform and continuous support.
  - 1. Blocking shall not be used to bring the pipe to grade.

### 3.3 INSTALLATION

- A. Pipe and fittings shall be installed in accordance with manufacturer's instruction and trench detail.
- B. Lower pipe into trench in a manner to prevent damage.
- C. Trench shall be dewatered prior to installing pipe.
  - 1. Dewater trench in accordance with the erosion and sedimentation control plan.
- D. Thoroughly clean pipe, inside and out, especially at the joints, before installation.
- E. Pipe installation:
  - 1. Prevent material from entering pipe while it is being placed.
  - 2. Assemble joints as pipe is placed.
  - 3. Place pipe to correct line and grade.
  - 4. Place approved backfill material to secure pipe in place.
- F. Begin laying pipe at bottom of grade and proceed upward with bell ends up grade.
- G. When pipe laying is not in progress, close open ends of pipe with water tight plug.

### 3.4 PUSH-ON JOINT ASSEMBLY

- A. Assemble joint in accordance with manufacturer's instructions.
- B. Clean gasket, bell interior and spigot area to remove any dirt or foreign material.
- C. Install gasket and lubricant in accordance with manufacturer's instructions.
- D. Assemble pipe by hand or with use of bar and block.
  - 1. Mechanical equipment, if required, may be used to install pipe eight inches in diameter and larger.
    - a. Be sure pipe is not installed past the depth mark.
- E. Pipe not furnished with depth mark shall be marked before assembly to assure that spigot end is inserted full depth of joint.

### 3.5 PIPE CUTTING

- A. Cut pipe at right angles to pipe axis.
- B. Pipe shall be cut using a pipe cutter, hacksaw, handsaw, or power handsaw.
- C. Ends of cut pipe shall be beveled to the correct taper.
- D. Round off sharp edges on leading edge of bevel.
- E. Mark pipe to obtain proper depth of insertion.

### 3.6 WASTEWATER MAINS NEAR WATER MAINS

- A. Horizontal separation:
  - 1. Place wastewater main at least ten feet from existing or proposed water main.
  - 2. If conditions prevent separation of ten feet:
    - a. Place the wastewater main in separate trench from water main.
    - b. Place wastewater main in trench with water with wastewater main pipe located at one side on a bench of undisturbed earth.
    - c. The elevation of the crown of the wastewater main shall be at least 18 inches below the invert of the water main for either case.
- B. Vertical separation:
  - 1. Should the wastewater main cross under a water main, the crown of the wastewater main shall be at least 18 inches below the invert of the water main.
  - 2. If conditions prevent separation of 18 inches; relocate the water main to provide the required separation or reconstruct water main with water tight joint pipe for a distance of ten feet on each side of wastewater main.
    - a. Center full length of pipe over wastewater main so that both joints are as far from wastewater main as possible.
- C. If conditions prevent both horizontal and vertical separations, construct both water main and wastewater main with water tight joints and pressure test each main to assure water tightness, then concrete encase wastewater main for a distance of ten feet on both sides of water main.

### 3.7 ANCHORING ON STEEP SLOPES

- A. Wastewater mains on 20 percent or greater slope shall be anchored with concrete. Maximum anchor spacing is as follows:
  - 1. 20 percent to 35 percent: 36 feet center to center.
  - 2. 35 percent to 50 percent: 24 feet center to center.
  - 3. 50 percent or greater: 16 feet center to center.
- B. Anchors are to be placed immediately downstream of pipe bells.

### 3.8 SERVICE LATERAL INSTALLATION

- A. It is the contractor's responsibility to coordinate with the property owner to identify the lateral location to service the property. The contractor shall leave a stake and note asking the property owner to identify the lateral location if they are not available during working hours.
- B. Wastewater service lateral shall be installed at a minimum slope of 1/4" per foot.
- A. The invert of any 4 inch lateral tapped into a manhole shall be 0.25 feet above the invert of the main.
- B. At the direction of the resident project representative, install a 45° bend at the wye connection. Bend to be incidental to unit price of wye.
- E. Extend lateral to property line. If main is already on a private property, extend lateral two feet.
- F. Locate end of lateral as conditions permit in area between sidewalk and curb or on building side of sidewalk or in lawn area.
- G. The end of a lateral shall not be installed in a roadway, paved areas, sidewalks, driveways, ditch or wet area, or in a location subject to vehicle travel.
- H. Cap and mark the location of the end of the lateral.
  - 1. Block cap to resist thrust of testing.
  - 2. Mark location with 2"x4" wooden stake.
  - 3. Stake to extend from cap to 1'-0" above ground.
  - 4. Place permanent mark on above ground portion of stake to denote the distance to invert of lateral.
- I. After testing, existing services, if present, shall be connected.
- J. Gravity service connections requiring a grinder pump will be provided with a typical gravity lateral.

### 3.9 TESTING



- A. Conduct alignment, deflection, and leakage testing of sewer mains.

END OF SECTION

## SECTION 333110

### TESTING OF WASTEWATER COLLECTION SYSTEM

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 DESCRIPTION

- A. Alignment testing of pipe shall be performed after backfilling has been completed.
- B. Deflection testing of pipe shall be performed at least 30 days after backfilling.
- C. Leakage testing of pipe shall be performed after laterals have been installed to property line and have been plugged adequately and braced to withstand the test pressure, and the trenches have been backfilled for a minimum of seven days as to generate a reasonable portion of the ultimate trench load upon the pipe.
- D. Manhole leakage testing shall be performed after assembly of manhole, grade rings and frame, but before backfilling.

##### 1.3 SUBMITTALS

- A. Contractor's certification that wastewater mains and laterals meet testing specification requirements.

#### PART 2- PRODUCTS

##### 2.1 EQUIPMENT

- A. Light source and accessories.
- B. Air compressor.
- C. Portable air control equipment.
  - 1. Consists of valves and pressure gages used to control the air entry rate to the test section and to monitor air pressure in the test section.
  - 2. Air control equipment shall include:
    - a. Shut-off valve.
    - b. Pressure regulating valve.
    - c. Pressure reduction valve.
    - d. Monitoring pressure gage.
      - 1. Pressure range: 0 to 10 psi.
      - 2. Minimum divisions: 0.10 psi.
      - 3. Accuracy:  $\pm 0.10$  psi.
- D. Portable vacuum testing equipment.
  - 1. Consists of valves and vacuum gages used to control and monitor vacuum in manhole.
  - 2. Gage:  $\pm 1$  percent accuracy.
  - 3. Vacuum pump.

#### PART 3- EXECUTION

##### 3.1 ALIGNMENT TEST

- A. Conduct testing throughout the entire collection system between consecutive manholes.
- B. Place source of light at center of pipe in the manhole at the end of pipe length being tested.

- C. A full circle of light must be seen in the manhole opposite where the light source is placed.
  - 1. If alignment test fails, make adequate repairs and retest.
  - 2. All repairs and retesting are to be performed at the contractor's expense.

### 3.2 DEFLECTION TEST

- A. Conduct testing throughout entire collection system.
- B. Test is to be performed using rigid balls or mandrels with diameters equal to 95 percent of the inside diameter of the pipe.
- C. Mechanical pulling devices are not acceptable.
- D. Maximum pipe deflection permissible is five percent.
- E. All repairs and retesting are to be performed at the contractor's expense.

### 3.3 PIPE LEAKAGE TEST

- A. Conduct testing throughout entire collection system, between consecutive manholes.
- B. Plug ends of the section of line to be tested and equipped for the air inlet connection for filling line.
- C. Brace all service laterals, plugs, stubs and fittings in the test section against internal pressure to prevent air leakage by slippage and blowouts.
- D. Connect air hose from tapped plug to portable air control equipment.
- E. Connect another air hose between air compressor and air control equipment.
- F. Slowly introduce air pressure to approximately 4.0 psig.
  - 1. If ground water is present, determine its elevation above the spring line, (the point at the center of the pipe at which the arch starts upward), of the pipe by means of a piezometric tube.
    - a. For every foot of ground water above the spring line of the pipe, increase the starting air test pressure reading by 0.43 psig.
      - 1. Do not increase test pressure above 10.0 psig.
- G. Allow pressure to stabilize for at least five minutes.
- H. Adjust pressure to 3.5 psig or the increase test pressure as determined above if ground water is present.
- I. Minimum acceptable time in seconds for a pressure drop from 3.5 psig to 3.0 psig is calculated by the following equation:
  - 1.  $T = 38.2 \times Dw$  where:
    - a.  $T$  = Elapsed time in seconds.
    - b.  $Dw$  = Weighted average pipe diameter.
- J. If the time for air pressure to drop from 3.5 to 3.0 psig is greater than that calculated by the above equation, the section undergoing test will pass.
- K. If the time for the 0.5 psig drop is less than that calculated, the section of pipe undergoing the test fails.
  - 1. All repairs and retesting are to be performed at the contractor's expense.

### 3.4 MANHOLE LEAKAGE TEST

- A. Plugs and brace pipe openings in manhole.
- B. Set vacuum tester in frame.
- C. Connect vacuum pump to outlet port of vacuum tester with valve open.
- D. Draw a vacuum to 10 inch of mercury and close valve.
- E. If the vacuum drops below 9 inches of mercury in one minute, the manhole fails the test.
  - 1. Make repairs and retest at contractor's expense.

### 3.5 ALTERNATE MANHOLE LEAKAGE TEST

- A. Plug and brace pipe openings in manhole.
- B. Fill manhole with water and leave overnight to allow for concrete absorption.
  - 1. Contractor is responsible for securing water for test.
  - 2. The following morning, fill the manhole to top of frame.
  - 3. Groundwater level shall be maintained below bottom of manhole during test.

- C. Test for leakage for one hour.
  - 1. At end of test period add sufficient water to bring water back to top of frame.
  - 2. Water shall be added from known size contained (ie 1 gallon graduated bucket).
  - 3. If the loss of water exceeds 0.20 gallons per foot of depth of manhole, in the one hour test period, the manhole fails the test.
- D. Disposal of test water shall not be via the sanitary sewer system. The contractor is responsible for disposing of the test water without causing a nuisance of excessive erosion.

### 3.6 LATERAL LEAKAGE TEST

- A. Acceptable tests include air test as stated above in section 3.03 and a water column test which includes a 10 foot column of water with no measurable water loss over a period of fifteen minutes.
  - 1. Water column test to be performed at foundation wall.
  - 2. Water being used for testing to fill the entire length of the lateral from foundation wall to observation port.
    - a. Water to be supplied by property owner.

### 3.7 FINAL ACCEPTANCE

- A. Conduct prior to customers connecting to system.
- B. Flush system to remove dirt and debris.
- C. Dewater collection system.
  - 1. Contractor is responsible for disposing of water without causing a nuisance or excessive erosion.
- D. Visual observation at lowest gravity manhole(s) must be dry.
  - 1. The required repairs and retesting shall be at the contractor's expense.

END OF SECTION

## SECTION 333900

### SANITARY UTILITY SEWERAGE STRUCTURES

#### PART 1 - GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUBMITTALS

- A. Manufacturer's product data and installation instructions.
- B. Shop drawings.
  - 1. Precast reinforced concrete manhole.
  - 2. Grade rings.
  - 3. Flexible gasket-type sealant.
  - 4. Manhole frame and cover.
  - 5. Manhole steps.
  - 6. Precast manhole-pipe gasket.
  - 7. Waterproofing.

##### 1.3 PRODUCT STORAGE AND HANDLING

- A. Do not store materials in State road Right-of-Way or in clear zones as per PaDOT Publication 203.

#### PART 2- PRODUCTS

##### 2.1 BASIS OF DESIGN

- A. Products listed are Basis of Design. "Or Equal" substitutions may be submitted but must be approved by the Professional if proven to be equal.

##### 2.2 MATERIALS

- A. Precast reinforced concrete manhole: ASTM C478.
  - 1. Manhole opening: 27 inch diameter.
  - 2. Inside diameter: 48 inch standard.
  - 3. Flanged base section.
  - 4. Pre-form openings in manhole base to accommodate service pipes at time of manufacture. Pipe gaskets are to be cast in place.
  - 5. Provide a bituminous, waterproof, sunlight resistant, coating on exterior of manhole, minimum dry film thickness 8 mils.
  - 6. Provide a waterproofing admixture by Xypex Chemical Corporation or equal for manholes specified on drawings.
  - 7. Provide eccentric top section or flat top as required.
  - 8. Provide grade rings as required.
  - 9. Acceptable for use in PaDOT right-of-way.
- B. Manhole frame and cover.
  - 1. Cast iron, ASTM A48, class 30.
  - 2. Standard
    - a. Frame/Cover: R-1753-A as mnfd by Neenah Foundry Co or equal.
  - 3. Watertight
    - a. Frame/Cover: R-1755-F2 as mnfd by Neenah Foundry Co or equal.
  - 4. Acceptable for use in PENNDOT right-of-way.

- C. Manhole steps:
  - 1. Polypropylene plastic manhole step, type PS4 by M.A. Industries, Inc or equal.
  - 2. 9-1/2" long x 12" wide.
  - 3. Conform to ASTM C478 Section 11.
  - 4. Steps grouted 3" to 4" into manhole wall during manufacture.
- D. Manhole pipe gasket:
  - 1. A-LOK manhole gasket as manufactured by A-LOK Products Inc., or equal.
- E. Flexible Butyl Resin Sealant by ConSeal or equal.
  - 1. Conform to Federal Specification SS-S-210A.
    - a. Install 2 layers.
- F. Ready mixed cement concrete for channel shall be 3,300 psi, equivalent to Pennsylvania Department of Transportation Class A cement concrete.
- G. Grout shall be ASTM C270, Type M.

### PART 3- EXECUTION

#### 3.1 INSTALLATION

- A. Construct manholes as sections of service between manholes are completed.
- B. Set manhole base on compacted aggregate at depth required to achieve the required pipe inverts.
- C. Join manhole sections, grade rings, and frame with flexible gasket-type sealant.
- D. Set manhole frame to grade using grade rings.
  - 1. Maximum height of combined grade rings is 12 inches.
  - 2. Use flat top section when manhole depth is 5'-0" or less or as shown on drawings.
- E. If field cutting of openings in manhole is necessary, install flexible pipe seal gasket, grout in place, and apply waterproofing.
- F. Concrete flow channels must be poured in place.
- G. The castings of manholes located on slopes are to be set to approximately match the slope.
- H. In pavement, shoulder or lawn areas, or within state right-of-way, manholes shall be installed so elevation at top of manhole cover is flush with finished pavement or grade elevation.
- I. Casting located in lawn areas on steep grades are to be set so casting is at slope of lawn.
- J. Top of manhole covers to be set six inches above grade with frame exposed in wooded areas or fields.
- K. Seal all lift holes in manhole walls with non-shrink grout.
- L. Install manhole pipe gasket in accordance with manufacturer's instructions.
- M. Pipe shall extend inside manhole a maximum of 2 inches.
- N. Invert channels shall be smooth, semi-circular in shape conforming to inside of adjacent sewer section where a change in direction of flow occurs, a smooth curve of as large a radius as size of manhole will permit shall be constructed. Special care shall be taken to keep concrete from running down in pipes when flow lines are poured. Pipes are to be "Dog housed."
- O. Fasten manhole frame to flat top or cone section and all grade rings of manhole with two 3/4 inch high strength low alloy steel all threads.
- P. In the case of leaking manholes, entire manhole shall be removed, re-gasketed and reset in place.

END OF SECTION

SECTION 333920  
SEWERAGE STRUCTURES RESTORATION

PART 1 – GENERAL

1.1 STIPULATIONS

- A. The specifications sections “General Conditions to the Construction Contract”, “Special Conditions” and “Division 01 – General Requirements” form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUBMITTALS

- A. Manufacturer’s product data and installation instructions.
- B. Shop Drawings
  - 1. Concrete restoration methods
  - 2. Manhole frame and cover restoration methods

PART 2 - PRODUCTS

2.1 BASIS OF DESIGN

- A. Products listed are Basis of Design. “Or Equal” substitutions may be submitted but must be approved by the Professional if proven to be equal.

2.2 MATERIALS

- A. Parson Environmental, Basis of Design
- B. Raven Lining Systems
- C. Epoxy TEC

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Surface preparation shall consist of water blasting (3,500 psi) entire interior of manhole to accomplish the removal of loose mortar, paints, protective coatings, rusts, efflorescence, all contaminants, laitance, and curing components, leave a clean structurally sound substrate. Wire brush and sandblast if required at no additional cost.
- B. Hydrostatic Leak Correction
  - 1. All leaks are to be stopped using the applicable products listed above in 2.2.
- C. Hydraulic Cement Patching
  - 1. Patching of manholes walls, base, flow channel or inverts shall be required in areas where large voids exist. All loose, cracked, and corroded material shall be removed, exposing a sound substrate. Apply cement patching to dampened surfaces.
- D. Liners
  - 1. Substrate should be water saturated.
  - 2. To be applied with wet mix shotcrete equipment.
  - 3. Application up to 4” in a single lift (1” minimum) as required to return surface to original dimensions.
  - 4. Finish by hand.
  - 5. Apply an integral corrosion barrier.
- E. Frame and Cone
  - 1. Apply product system. Joints shall be free of all loose material and contaminants.

- F. Invert/Flow Channel
  - 1. Plug line and remove any standing water.
  - 2. Apply product ½" thick.
  - 3. Trowel smooth.
- G. Curing
  - 1. Allow proper time to cure between applications.
- H. Waste
  - 1. Properly dispose of all waste and ensure that no waste remains in sewer lines.
- I. Testing
  - 1. Manholes to be tested as required.

### 3.2 WARRANTY

- A. Provide a two (2) year warranty to include all workmanship, materials, and labor.

END OF SECTION



## SECTION 333923

### SANITARY UTILITY SEWERAGE CLEANOUTS

#### PART 1- GENERAL

##### 1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

##### 1.2 SUBMITTALS

- A. Manufacturer's literature, illustrations, and installation instructions.
- B. Shop drawings.

#### PART 2- PRODUCTS

##### 2.1 MATERIALS

- A. Traffic load areas.
  - 1. Cast iron frame and cover.
  - 2. Concrete - Pennsylvania Department of Transportation Class A, 3,300 psi.
  - 3. PVC SDR 35 pipe and fittings: Section 02731.

#### PART 3- EXECUTION

##### 3.1 LOCATION

- A. As shown on drawings.

##### 3.2 INSTALLATION

- A. Set to grade indicated on drawings.
- B. 6" minimum concrete surrounding vertical section of pipe.
- C. Cast iron frame and cover; bed frame in cement mortar.

END OF SECTION

SECTION 334100  
STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUBMITTALS

- A. Certificates:
  - 1. Delivery tickets.

1.3 QUALITY ASSURANCE

- A. A manufacturer's certificate that the product was manufactured, tested, and supplied in accordance with this specification, together with a report of the test results, and the date each test was completed, shall be furnished upon request. Each certification so furnished shall be signed by a person authorized by the manufacturer.

1.4 MARKING

- A. All pipe shall be clearly marked at intervals of no more than 10 feet (3 m) as follows:
  - 1. Manufacturer's name or trademark.
  - 2. Nominal size.
  - 3. This specification designation, AASHTO M 294.
  - 4. The plant designation code.
  - 5. The date of manufacture or an appropriate code.
- B. Fittings shall be marked with the designation number of this specification, AASHTO M 294, and with the manufacturer's identification symbol.

1.5 PRODUCT DELIVERY STORAGE, AND HANDLING

- A. Protect materials during transportation and installation to avoid physical damage.
- B. Set aside pipe damaged during delivery or unloading.
- C. Stockpile pipe as near as possible to where pipe will be installed.

PART 2 - PRODUCTS

2.1 BASIS OF DESIGN

- A. Products listed are Basis of Design. "Or Equal" substitutions may be submitted but must be approved by the Professional if proven to be equal.

2.2 BASIC MATERIALS

- A. Extruded Pipe and Blow Molded Fittings: Pipe and fittings shall be made of virgin PE compounds which conform with the requirements of cell class 324420C as defined and described in ASTM D 3350, except that the carbon black content shall not exceed 5%. Compounds that have higher cell classifications in one or more properties are acceptable provided product requirements are met.
- B. Rotational Molded Pipe and Fittings: Pipe and fittings shall be made of virgin PE compounds which conform with the requirements of cell class 213320C as defined and described in ASTM D 3350, except that the carbon black content shall not exceed 5%. Compounds that

have higher cell classifications in one or more properties are acceptable provided product requirements are met.

### 2.3 REWORKED MATERIAL

- A. In lieu of virgin PE, clean reworked material may be used by the manufacturer, provided that it meets the cell class requirements as described in 2.01B.

### 2.4 REQUIREMENTS

- A. Workmanship: The pipe and fittings shall be free of foreign inclusions and visible defects as defined herein. The ends of the pipe shall be cut squarely and cleanly so as not to adversely affect joining or connecting.
  - 1. Visible Defects: Cracks, creases, unpigmented or nonuniformly pigmented pipe are not permissible in the pipe as furnished.
  - 2. For Type S pipe, the inner liner shall be fused to the outer corrugated shell at all internal corrugation crests.
- B. Pipe Dimensions:
  - 1. Nominal Size: The nominal size for the pipe and fittings is based on the nominal inside diameter of the pipe. Nominal diameters shall be 12, 15, 18, 24, 30 and 36 inches (305, 380, 455, 610, 760, and 916 mm).
  - 2. Inside Diameter Tolerances: The tolerance on the specified inside diameter shall be 3% oversize and 1.5% undersize, but not more than 1/2 in. (12.7 mm) either oversize or undersize when measured in accordance with ASTM D 2122.
  - 3. Length: Corrugated PE pipe may be sold in any length agreeable to the user. Lengths shall not be less than 99 percent of the stated quantity.
- C. Perforations: When perforated pipe is specified, the perforations shall conform to the requirements of Class 2, unless otherwise specified in the order. Class 1 perforations are for pipe intended to be used for subsurface drainage or combination storm and underdrain. Class 2 perforations are for pipe intended to be used for subsurface drainage only. The perforations shall be cleanly cut so as not to restrict the inflow of water. Pipe connected by couplings or bands may be unperforated within 4 inches (100 mm) of each end of each length of pipe.
  - 1. Class 1 Perforations: The perforations shall be approximately circular and shall have nominal diameters of not less than 3/16 inch (4.8 mm) nor greater than 3/8 inch (9.5 mm) and shall be arranged in rows parallel to the axis of the pipe. The perforations shall be located in the external valleys with perforations in each row for each corrugation. The rows of perforations shall be arranged in two equal groups placed symmetrically on either side of the lower unperforated segment corresponding to the flow line of the pipe. The spacing of the rows shall be uniform. The distance between the centerlines of the rows shall not be less than 1 inch (25 mm).
  - 2. Class 2 Perforations: Circular perforations shall be a minimum of 1/4 inch (6.4 mm) and shall not exceed 3/8 inch (9.5 mm) in diameter. The width of slots shall not exceed 1/8 inch (3.2 mm). The length of slots shall not exceed 2.5 inches (64 mm) for 12 inch (305 mm) and 15 inch (380 mm) pipe and 3.0 inch (77 mm) for 18 inch (455 mm) and large pipe. Perforations shall be placed in the external valleys and uniformly spaced along the length and circumference of the pipe. The water inlet area shall be a minimum of 1.5 square inch per linear foot (31.8 sq. cm./m) for pipe sizes 12 to 18 inch (305 to 455 mm) and 2.0 sq. in. per linear foot (42.3 sq. cm./m) for pipe sizes larger than 18 inch (455 mm).
- D. Pipe Stiffness: The pipe shall have a minimum pipe stiffness at five percent deflection as follows when tested in accordance with ASTM D 2412.

DIAMETER (inches)	PIPE STIFFNESS (psi)
----------------------	-------------------------

12 (305 mm)	50 (344 kPa)
15 (380 mm)	42 (289 kPa)
18 (455 mm)	40 (276 kPa)
24 (610 mm)	34 (235 kPa)
30 (760 mm)	28 (193 kPa)
36 (915 mm)	22 (152 kPa)

- E. Pipe Flattening: There shall be no evidence of wall buckling, cracking, splitting, or delamination, when the pipe is tested in accordance with ASTM D 2412.
- F. Environmental Stress Cracking: There shall be no cracking of the pipe when tested in accordance with ASTM D 1693.
- G. Brittleness: Pipe specimens shall not crack or split when tested in accordance with ASTM D 244. Five non-failures out of six impacts will be acceptable.
- H. Fittings Requirements:
1. The fittings shall not reduce or impair the overall integrity or function of the pipe line.
  2. Common corrugated fittings include in-line joint fittings, such as couplings and reducers, and branch or complimentary assembly fittings such as tees, wyes, and end caps. These fittings are installed by various methods, such as snap-on, screw-on, and wrap around.  
NOTE: Only fittings supplied or recommended by the pipe manufacturer should be used. Joints shall be watertight. Soil tightness is a function of opening size, channel length, and backfill particle size. A backfill material containing a high percentage of fine-graded soils requires investigation for the specific type of joint to be used to guard against soil infiltration. Information regarding joint soil tightness criteria can be found in AASHTO Standard Specifications for Highway Bridges, Division II, Section 23 "Construction and Installation of Soil Metal Plate Structure Interaction Systems."
  3. All fittings shall be within an overall length dimensional tolerance  $\pm 0.5$  inch ( $\pm 12.7$  mm) of the manufacturer's specified dimensions.
  4. Fittings shall not reduce the inside diameter of the pipe being jointed by more than 0.5 inch (12.7 mm). Reducer fittings shall not reduce the cross-sectional area of the small size.
  5. Couplings shall be corrugated to match the pipe corrugations and shall provide sufficient longitudinal strength to preserve pipe alignment and prevent separation at the joints. Couplings shall be bell and spigot, split collar, or screw-on collar. Split collar couplings shall engage at least two full corrugation on each pipe section and screw on collars shall be in width at least one-half the nominal diameter of the pipe.
  6. Pipe connections shall not separate to create a gap exceeding 3/16 inch (4.8 mm) when measured in a radial direction between pipe and coupling, or between tongue and groove portions of pipe.
  7. The design of the fittings shall be such that when connected with the pipe, the axis of the assembly will be level and true.
  8. Other types of coupling bands or fastening devised which are equally effective as those described, and which comply with the joint performance criteria of AASHTO Standard Specification for Highway Bridges, Division II, Section 23, may be used when approved by the purchaser.

### PART 3 - EXECUTION

#### 3.1 INSPECTION

- A. Examine areas to receive pipes for:

1. Complete excavation to elevations and slopes indicated.
  2. Obstructions which would interfere with pipe installation.
- B. Examine pipe sections for dents, bends, holes, missing coatings, etc.

### 3.2 INSTALLATION

- A. Line and grade: As shown on drawings.
- B. Provide suitable outlet.
- C. Begin at downstream end.
- D. Place bedding material to elevation of pipe bottom.
- E. Place pipe sections on bedding material.
- F. Place bedding material around side of pipe and tamp without disturbing pipe position.
- G. Minimum cover over pipe under subgrade elevation: 12 inches.
- H. Check completed piping to assure joints are intact.

END OF SECTION

SECTION 334900  
STORM DRAINAGE STRUCTURES

PART 1 – GENERAL

1.1 STIPULATIONS

- A. The specifications sections “General Conditions to the Construction Contract”, “Special Conditions” and “Division 01 – General Requirements” form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUBMITTALS

- A. Shop drawings:
  - 1. Precast concrete inlets.
  - 2. Grates.
  - 3. Frames.

PART 2- PRODUCTS

2.1 MATERIALS

- A. Precast cement concrete inlets, grates, and frames: comply with Pennsylvania Department of Transportation, Bureau of Design Standards for Roadway Construction, Standard Drawings Number RC-34 (6 sheets).
- B. Backfill material: PENNDOT No. 2RC aggregate.
- C. Masonry mortar: ASTM C270, Type M.

PART 3- EXECUTION

3.1 PLACING PRECAST CEMENT CONCRETE INLETS

- A. Place inlet to conform to line and grade shown on drawings.
- B. Place pipes at inlet flush with inside face of inlet.
- C. Set frames, concrete top units, and grade adjustment rings in full mortar beds.

3.2 BACKFILLING

- A. Backfill spaces adjacent to inlet with PENNDOT No. 2RC aggregate compacted in four inch layers.

END OF SECTION



(717) 787-1911

September 6, 2022

Kurt Thompson  
Hord Coplan Macht  
1213 West Morehead Street, Suite 500  
Charlotte, NC 28208

File No.: ID #341402-03  
Plan Reviewer: Gary W. Stabler  
Drawing Index: H-22-0933  
Approval Date: 09/06/2022

**RE: Hollidaysburg Veterans' Home  
Construction of a new 200-bed skilled nursing building to consolidate existing resident beds from two other buildings on the campus.**

Dear Mr. Thompson:

Plans for the subject project have been approved. This is a Type II (222) Fully Sprinklered building construction as per NFPA 220 and shall comply with the NFPA 101, "Life Safety Code," 2012 Edition, including Chapter 2 and all Long-term Care Licensure Regulations as adopted by the Pennsylvania Department of Health.

**Sprinkler Shop Drawings are Required**

If changes were required on your plans to obtain the final plan approval, these changes are shown as red markings on the plans and must be incorporated in the construction before the project will receive final inspection and occupancy approval. If formal sprinkler drawings are required, or if partial occupancy approval is requested, no occupancy will be granted without those drawings being submitted and approval of plans for revisions or changes that affect the original approval. Sufficient lead-time should be allowed for approval of plans and scheduling of inspections.

The Division of Safety Inspection must be notified when construction has started and when construction has been completed. NOTIFY IN WRITING: Mark Trocchio, Safety Inspection Supervisor, Pittsburgh Field Office, 11 Stanwix Street, Room 410, Pittsburgh, PA 15222

Failure to notify the Department of Health, Division of Safety Inspection, that the construction proposed by these plans is completed, and/or the use and occupancy of the property prior to the issuance of an Occupancy Approval or a construction survey acceptance letter by this Department, constitutes a violation of the Health Care Facilities Act, Act #48, P.L. 130 and licensure regulations. Violations are subject to penalties and prosecutions prescribed by law.

Sincerely,

A handwritten signature in black ink, appearing to read "Charles Schlegel".

Charles Schlegel, Director  
Division of Safety Inspection

CS:GWS:LNU

cc: Hollidaysburg Veterans' Home  
Division of Nursing Care Facilities  
Pittsburgh DSI Field Office  
DSI Central File



March 2, 2022

Mr. Kevin Ferner  
PA Department of Veterans Affairs  
Building 11-64, Utility Road, Fort Indiantown Gap  
Annville, PA 17002-5003

Re: General Permit Acknowledgment  
Hollidaysburg Veterans Home Utility Extensions  
DEP General Permit File No. GP050703221-014  
APS ID No. 1055096  
Allegheny Township, Blair County

Dear Mr. Ferner:

This letter acknowledges receipt of your notification to use and registers your use of a General Permit (GP) under the authority of the Dam Safety and Encroachments Act (32 P. S. § 693.1 et. seq.) and 25 Pa. Code Chapter 105 to install and maintain a 4.0-inch diameter HDPE natural gas line under and across an unnamed tributary to the Beaverdam Branch of the Juniata River (TSF, MF) via open cut, impacting 35 linear feet of stream, for the purpose of serving a new nursing facility. The project is located approximately 1,200 feet to the southwest of the intersection of Fox Hollow Road and Plank Road (Latitude: 40.442325°N; Longitude: 78.413039°W) in Allegheny Township, Blair County. No wetlands will be impacted by this project. You are responsible for assuring the work is done in accordance with the drawings, terms and conditions contained in the GP(s). Please direct special attention to all time sensitive issues associated with the GP authorization(s). You may proceed with your project after making the required notifications stipulated in the GP(s) and securing all other approvals that may be necessary.

Please place this letter with your copy of the GP Registration package, the applicable GP terms and conditions, required Federal authorizations, and the Erosion and Sediment Control plan and maintain on site during construction. Please review the complete permit authorization package so that you are aware of the extent of authorization(s).

We have determined that your proposed work, if accomplished in accordance with the enclosed terms and conditions, is authorized by the Pennsylvania State Programmatic General Permit-6 (PASPGP-6). This PASPGP-6 verification provides U.S. Army Corps of Engineers authorization pursuant to Section 10 of the Rivers and Harbors Act and/or Section 404 of the Clean Water Act. This authorization may be subject to modification, suspension, or revocation if any of the information contained in the application, including the plans, is later found to be in error. The enclosed list of conditions must be followed for purposes of the PASPGP-6.

Any person aggrieved by this action may appeal the action to the Environmental Hearing Board (Board), pursuant to Section 4 of the Environmental Hearing Board Act, 35 P.S. § 7514, and the Administrative Agency Law, 2 Pa.C.S. Chapter 5A. The Board's address is:



Environmental Hearing Board  
Rachel Carson State Office Building, Second Floor  
400 Market Street  
P.O. Box 8457  
Harrisburg, PA 17105-8457

TDD users may contact the Environmental Hearing Board through the Pennsylvania Relay Service, 800.654.5984.

Appeals must be filed with the Board within 30 days of receipt of notice of this action unless the appropriate statute provides a different time. This paragraph does not, in and of itself, create any right of appeal beyond that permitted by applicable statutes and decisional law.

A Notice of Appeal form and the Board's rules of practice and procedure may be obtained online at <http://ehb.courtapps.com> or by contacting the Secretary to the Board at 717.787.3483. The Notice of Appeal form and the Board's rules are also available in braille and on audiotape from the Secretary to the Board.

**IMPORTANT LEGAL RIGHTS ARE AT STAKE. YOU SHOULD SHOW THIS DOCUMENT TO A LAWYER AT ONCE. IF YOU CANNOT AFFORD A LAWYER, YOU MAY QUALIFY FOR FREE PRO BONO REPRESENTATION. CALL THE SECRETARY TO THE BOARD AT 717.787.3483 FOR MORE INFORMATION. YOU DO NOT NEED A LAWYER TO FILE A NOTICE OF APPEAL WITH THE BOARD.**

**IF YOU WANT TO CHALLENGE THIS ACTION, YOUR APPEAL MUST BE FILED WITH AND RECEIVED BY THE BOARD WITHIN 30 DAYS OF RECEIPT OF NOTICE OF THIS ACTION.**

If you have additional questions about your registration, please call Jason Shirey at 717.705.4818 and refer to Application No. GP050703221-014.

Sincerely,

Edward J. Muzic

Edward J. Muzic, P.E.  
Civil Engineer Manager, Hydraulic  
Dam Safety, Waterways & Wetlands Section

Enclosure

cc: Blair County Conservation District (email)  
Ms. Theodora Kreitz, CPESC, CFM, Keller Engineers (email)

**PENNSYLVANIA STATE PROGRAMMATIC GENERAL PERMIT – 6**  
**(PASPGP-6)**  
**July 1, 2021**

**Please note: the full text of the PASPGP-6 may be viewed on the Baltimore District web site at <http://www.nab.usace.army.mil/Missions/Regulatory/PermitTypesandProcess.aspx> or by calling the Corps at 814-235-0570**

**Permittee:**

**Date of PASPGP-6 Verification:**

**State Authorization(s):**

**Corps District:**

**Baltimore District**

U.S. Army Corps of Engineers State College Field Office  
1631 South Atherton Street  
Suite 101  
State College, Pennsylvania 16801-6260  
**Email:** [NAB-Regulatory@usace.army.mil](mailto:NAB-Regulatory@usace.army.mil)

**Philadelphia District**

U.S. Army Corps of Engineers  
Wanamaker Building  
100 Penn Square East Regulatory Branch  
Philadelphia, Pennsylvania 19107-3390  
**Email:** [PhiladelphiaDistrictRegulatory@usace.army.mil](mailto:PhiladelphiaDistrictRegulatory@usace.army.mil)

**Pittsburgh District**

U.S. Army Corps of Engineers, Regulatory Branch  
William S. Moorhead Federal Building, 20<sup>th</sup> floor  
1000 Liberty Avenue  
Pittsburgh, Pennsylvania 15222-4186  
**Email:** [Regulatory.Permits@usace.army.mil](mailto:Regulatory.Permits@usace.army.mil)

It has been determined that your proposed project, which includes the discharge of dredged and/or fill material and/or the placement of structures into waters of the United States, including wetlands, qualifies for federal authorization under the provisions of Section 404 of the Clean Water Act and /or Section 10 of the River and Harbor Act of 1899, under the terms and conditions of the PASPGP-6.

**All activities authorized under PASPGP-6 must comply with all conditions of the authorization, including General, Procedural, and Special Conditions. Failure to comply with all the conditions of the authorization, including project special conditions, will constitute a permit violation and may be subject to criminal, civil, or administrative penalties, and /or restoration.**

The authorized activity must be performed in compliance with the following General Conditions to be authorized under PASPGP-6:

**General Conditions:**

1. Permit Conditions: The permittee shall conduct all work and activities in waters of the United States, including jurisdictional wetlands, in strict compliance with the approved authorization/verification including all final maps, plans, profiles, and design specifications.
2. 401 State Water Quality Certification (SWQC) Conditions: The permittee shall comply with the following conditions unless a project specific SWQC is required as identified below:
  - a. Prior to beginning any activity authorized by the Corps under PASPGP-6, the applicant shall obtain from the Department all necessary environmental permits, authorizations or approvals, and submit to the Department environmental assessments and other information necessary to obtain the permits and approvals, as required under state law, including The Clean Streams Law (35 P.S. §§ 691.1—691.1001), the Dam Safety and Encroachments Act (32 P.S. §§ 693.1—693.27), the Surface Mining Conservation and Reclamation Act (52 P.S. §§ 1396.1—1396.19b), the Noncoal Surface Mining Conservation and Reclamation Act (52 P.S. §§ 3301—3326), the Bituminous Mine Subsidence and Land Conservation Act (52 P.S. §§ 1406.1—1406.21), the Coal Refuse Disposal Control Act (52 P.S. §§ 30.51—30.66), the Solid Waste Management Act (35 P.S. §§ 6018.101—6018.1003), the Hazardous Sites Cleanup Act (35 P.S. §§ 6020.101—6020.1305), the Land Recycling and Environmental Remediation Standards Act (35 P.S. §§ 6026.101—6026.908), 58 Pa.C.S. §§ 3201—3274 (related to development), the Air Pollution Control Act (35 P.S. §§ 4001—4015), the Storage Tank and Spill Prevention Act (35 P.S. §§ 6021.101—6021.2104) and the regulations promulgated thereunder, including 25 Pa. Code Chapters 16, 71, 77, 78, 78a, 86—91, 92a, 93, 95, 96, 102, 105, 106, 127, 245 and 260a—299.
  - b. Fill material may not contain any wastes as defined in the Solid Waste Management Act.
  - c. Applicants and projects eligible for the PASPGP-6 must obtain all state permits or approvals, or both, necessary to ensure that the project meets the state's applicable water quality standards, including a project-specific SWQC.

Note: As part of PADEP's issuance of 401 SWQC for PASPGP-6 on February 12, 2021, the following was included to clarify the meaning of this condition:

This 401 SWQC is only available for projects that do not require any federal authorization other than authorization from the Corps under Section 404 of the Act or Section 10 of the Rivers and Harbors Act of 1899. Applicants seeking authorization for activities not eligible for coverage under PASPGP-6, or for activities that require another federal authorization (such as an interstate natural gas pipeline, a gas storage field or a nuclear or hydroelectric project requiring authorization by another federal agency), must submit a request to the Department for a project-specific SWQC. The scope of the issuance of this SWQC is related only to the scope and applicability of the proposed PASPGP-6. Any activity or project requiring the Department to

issue 401 SWQC that is beyond the scope of the proposed PASPGP-6 or other programmatically issued SWQC (e.g. Nationwide Permits) will require the applicant to obtain a project-specific SWQC from the Department. This would include any activity or project requiring a SWQC associated with an authorization, permit or license issued by a federal agency, such as Federal Energy Regulatory Commission or Nuclear Regulatory Commission. Such activities or projects include, but are not limited to, an interstate natural gas pipeline, a gas storage field or a nuclear or hydroelectric project.

3. Terms and Conditions Related to Coastal Zone Management Act (CZMA) Certification: For those projects located within Pennsylvania's Coastal Zones, Non-Reporting Activities have General CZMA consistency determination and Reporting Activities must obtain individual CZMA consistency determination (see General Condition 30(b)).
4. Aquatic Life Movements: No activity may substantially disrupt the necessary life cycle movements of those species of aquatic life indigenous to the waterbody, including those species that normally migrate through the area, unless the activity's primary purpose is to impound water. All permanent and temporary crossings of waterbodies shall be suitably culverted, bridged, or otherwise designed and constructed to maintain low flows to sustain the movement of those aquatic species. If a bottomless crossing cannot be used, then culverts should be designed, constructed, and appropriately depressed, if possible, below the stream invert to minimize adverse effects to aquatic life movements.
5. Threatened and Endangered Species: By signing the Pennsylvania Natural Diversity Inventory (PNDI) receipt, the permittee has agreed to comply with all avoidance measures identified by the PNDI receipt. The applicant may also agree in writing to comply with all avoidance measures identified in U.S. Fish and Wildlife Service (USFWS) correspondence, including IPaC, as part of the application. To ensure compliance with the Endangered Species Act (ESA), those avoidance measures associated with federally listed, threatened, or endangered species are a condition of the PASPGP-6 verification, unless modified by the Corps.

If an activity is verified under the PASPGP-6, and a federally listed, threatened, or endangered species, or proposed species, is subsequently found to be present, all work must cease, and the Corps and USFWS (or National Marine Fisheries Service (NMFS)) must be notified by telephone immediately (contact information below). The PASPGP-6 verification is automatically suspended without additional notification to the permittee and will not be re-issued until consultation pursuant to Section 7 of the ESA is concluded and adverse effects to federally listed, threatened, endangered, and proposed species are avoided, or incidental take authorization issued.

Furthermore, persons have an independent responsibility under Section 9 of the ESA to avoid any activity that could result in the "take" of a federally listed species.

USFWS:  
Pennsylvania Field Office  
110 Radnor Rd; Suite 101  
State College, PA 16801  
office phone: 814 234-4090  
fax: 814-234-0748 or 814 206-7452

NMFS:  
Ms. Jennifer Anderson  
Assistant Regional Administrator  
Protected Resources Division NOAA Fisheries  
55 Greater Republic Drive  
Gloucester, Massachusetts 01930

6. Spawning Areas: The permittee shall comply with all time-of-year-restrictions (see below) associated with spawning areas as set forth by the Pennsylvania Fish and Boat Commission (PFBC) or other designated agency. Discharges or structures in spawning or nursery areas shall not occur during spawning seasons unless written approval is obtained from the PFBC or another designated agency. In addition, work in areas used for other time sensitive life span activities of fish and wildlife (such as hibernation or migration) may necessitate the use of seasonal restrictions for avoidance of adverse impacts to vulnerable species. Impacts to these areas shall be avoided or minimized to the maximum extent practicable during all other times of the year.

Wild Trout	October 1 - December 31
Class A Wild Trout	October 1 - April 1

List of Trout Streams found at:

<https://www.fishandboat.com/Fish/PennsylvaniaFishes/Trout/Pages/TroutWaterClassifications.aspx>.

7. Shellfish Production: No discharge of dredged and/or fill material and/or the placement of structures may occur in areas of concentrated shellfish production, unless the discharge is directly related to an authorized shellfish harvesting activity.
8. Adverse Effects From Impoundment: If the regulated activity creates an impoundment of water, the adverse effects on the aquatic system caused by the accelerated passage of water and/or the restriction of its flow, including impacts to wetlands, shall be minimized to the maximum extent practicable.
9. Management of High Flows: To the maximum extent practicable, the preconstruction course, condition, capacity, and location of open waters must be maintained for each activity, including stream channelization, storm water management activities, and temporary and permanent road crossings, except as provided below. The activity must be constructed to withstand expected high flows. The activity must not restrict or impede the passage of normal or high flows unless the primary purpose of the activity is to impound water or manage high flows. The activity may alter the pre-construction course, condition, capacity,

and location of open waters if it benefits the aquatic environment (e.g., stream restoration or relocation activities).

10. Erosion and Sediment Controls: Appropriate soil erosion and sediment controls, in accordance with state regulations, must be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, must be permanently stabilized at the earliest practicable date. Permittees are encouraged to perform work within waters of the United States, including jurisdictional wetlands, during periods of low-flow or no-flow, or during low tides.
11. Suitable Material: No activities, including discharges of dredged and/or fill material or the placement of structures, may consist of unsuitable material (i.e., asphalt, trash, debris, car bodies, etc.). No material discharged shall contain toxic pollutants in amounts that would violate the effluent limitation standards of § 307 of the Clean Water Act (CWA).
12. Temporary Fill and Structures: Temporary fill (i.e., access roads and cofferdams) and structures in waters and/or wetlands authorized by PASPGP-6 shall be properly constructed and stabilized during use to prevent erosion and accretion. Temporary fill in wetlands shall be placed on geotextile fabric laid on existing wetland grade, unless such requirement is specifically waived by the Corps. Whenever possible, rubber or wooden mats should be used for equipment access through wetlands to the project area. Temporary fills and structures shall be removed, in their entirety, to an upland site, and suitably contained to prevent erosion and transport to a waterway or wetland. Temporarily impacted areas shall be restored to their preconstruction contours, elevations, and hydrology, and revegetated with a wetland seed mix that contains non-invasive, native species, to the maximum extent practicable. Unless approved by the Corps, the restoration work must be completed within 30 days of the date the temporary fill/structure is no longer needed.
13. Equipment Working in Wetlands: Heavy equipment working in wetlands or mudflats must be placed on mats, or other measures must be taken to minimize soil disturbance.
14. Installation and Maintenance: Any regulated structure or fill authorized by PASPGP-6 shall be properly installed and maintained to ensure public safety.
15. PASPGP-6 Authorization:
  - a. PASPGP-6 expires June 30, 2026, unless suspended or revoked.
  - b. Verifications of PASPGP-6 expire June 30, 2026, unless the PASPGP-6 permit is suspended, revoked, or the PADEP authorization expires, whichever date occurs sooner. Activities authorized under PASPGP-6 that have commenced construction or are under contract to commence construction will remain authorized provided the activity is completed within 12 month of the date of the PASPGP-6 expiration, modification, or revocation; or until the expiration date of the project specific verification, whichever is sooner.

16. One-Time Use: A PASPGP-6 verification is valid to construct the project, or perform the activity, one time only, except for PASPGP-6 verifications specifically issued for reoccurring maintenance activities.
17. Water Supply Intakes: No regulated activity may occur in the proximity of a public water supply intake and adversely impact the public water supply. In order to minimize the effects of intakes on anadromous fish eggs and larvae, and oyster larvae, intake structures should be equipped with screening (with mesh size no larger than 2 mm) of wedge wire or another material of equal or better performance. Where feasible, intakes should be located away from spawning or nursery grounds, or to minimize the impingement on, or entrainment of, eggs or larvae. In addition, intake velocities should not exceed 0.5 ft/sec.
18. Historic Properties: For all activities verified under a PASPGP-6, upon the unanticipated discovery of any previously unknown historic properties (historic or archeological), all work must cease immediately, and the permittee must notify the State Historic Preservation Officer (SHPO) and the Corps. The Corps will contact the tribes with whom they routinely consult, within 24 hours in accordance with each District's tribal consultation process. PASPGP-6 may be re-verified, and special conditions added if necessary, after an effect's determination on historic properties and/or tribal resources is made, in consultation with the SHPO, the tribes and other interested parties. The PASPGP-6 verification may be modified and/or rescinded for the specific activity if an adverse effect on the historic property cannot be avoided, minimized, or mitigated.
19. Tribal Rights: No activity or its operation may impair reserved tribal rights, including, but not limited to, reserved water rights and treaty fishing and hunting rights.
20. Corps Civil Works Projects: The PASPGP-6 does not authorize any work which will interfere with an existing or proposed Corps Civil Works project, or any Corps-owned or managed property or easement (i.e., flood control projects, dams, reservoirs, and navigation projects), unless specifically approved by the Corps in writing. Pursuant to 33 U.S.C 408, a review by, or permission from the Corps is required for activities that will alter or temporarily or permanently occupy or use a Corps federally authorized Civil Works project. Any activity that requires Section 408 permission and/or review is not authorized by PASPGP-6 until the appropriate Corps office issues the Section 408 permission or completes its review to alter, occupy, or use the Corps Civil Works project, and Corps issues a written PASPGP-6 verification.
21. Navigation: No activity verified under PASPGP-6 may cause more than minimal adverse effect on navigation. No attempt shall be made by the permittee to prevent the full and free use by the public of all navigable waters at or adjacent to the activity authorized herein. In addition, activities that require temporary causeways that prohibit continued navigational use of a waterway (i.e., temporary causeways extending greater than  $\frac{3}{4}$  the width across the waterway) shall be removed in their entirety upon completion of their use. Any safety lights and signals prescribed by the U.S. Coast Guard (USCG), through regulation or otherwise, must be installed and maintained at the permittee's expense on authorized facilities in navigable waters of the United States. The permittee understands and agrees that, if further operations by the United States require the removal, relocation, or other alteration, of the

structure or work herein authorized, or if, in the opinion of the Secretary of the Army or an authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the permittee will be required, upon due notice from the Corps, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

22. Inspections: The permittee shall allow a District Engineer or an authorized representative(s) to make periodic inspections at any time deemed necessary in order to ensure that the work is being performed in accordance with all the terms and conditions of PASPGP-6. The District Engineer may also require post-construction engineering drawings (as-built plans) for completed work.
23. Modifications of Prior Verifications: Any proposed modification of a previously verified Single and Complete project that results in a change in the verified impact to, or use of waters of the United States, including jurisdictional wetlands, must be approved by PADEP, or the Corps if applicable. Corps written approval is required if the prior verification was reviewed by the Corps, or if the proposed modification is a Reporting Activity under PASPGP-6. Project modifications that cause a Single and Complete Project to exceed 0.5 acre of loss of waters of the United States, including jurisdictional wetlands (except those identified in Part II A.2. a. and b.), or greater than 1,000 linear feet of permanent jurisdictional stream loss (except those identified in Part II A.2. a and b.), are not eligible for PASPGP-6 and will be forwarded to the Corps for review under an alternative permit review procedure.
24. Recorded Conservation Instruments: As per Part III.D.27 and Part III.E.8 of this permit, proposed Draft Conservation Instruments may be submitted by the applicant as part of the permit application package for review and approval. When such proposed Conservation Instruments are submitted by the applicant, proof of the recorded deed restriction, conservation easement, or deed restricted open space area shall be forwarded to the appropriate Corps District and appropriate PADEP offices, prior to the initiation of any permitted work, unless specifically waived by the Corps in writing. Conservation Instrument templates can be found at:  
<http://www.nab.usace.army.mil/Missions/Regulatory/PermitTypesandProcess.aspx>
25. Property Rights: PASPGP-6 does not obviate the need to obtain other federal, state, or local authorizations required by law, nor does the permit grant any property rights or exclusive privileges or authorize any injury to the property or rights of others.
26. Navigable Waters of the United States (Section 10 Waters):

In addition to the other general conditions, the following conditions are applicable for activities in the eligible navigable waters of the United States identified in Appendix B:

- a. For aerial transmission lines, the following minimum clearances are required for aerial electric power transmission lines crossing navigable waters of the United States. These clearances are related to the clearances over the navigable channel provided by the



existing fixed bridges, or the clearances which would be required by the USCG for new fixed bridges, in the vicinity of the proposed aerial transmission line. These clearances are based on the low point of the line under conditions producing the greatest sag, taking into consideration temperature, load, wind, length of span, and type of supports as outlined in the National Electric Safety Code:

Nominal System Voltage (kV)	Minimum Additional Clearance (ft.) Above Clearance Required for Bridges
115 and below	20
138	22
161	24
230	26
350	30
500	35
700	42
750-765	45

- i. Clearances for communication lines, stream gauging cables, ferry cables, and other aerial crossings must be a minimum of ten feet above clearances required for bridges, unless specifically authorized otherwise by the District Engineer.
  - ii. Corps regulation ER 1110-2-4401 prescribes minimum vertical clearances for power communication lines over Corps lake projects. In instances where both regulation and ER 1110-2-4401 apply, the greater minimum clearance is required.
- b. Encasement: The top of any cable, encasement, or pipeline shall be located a minimum of three feet below the existing bottom elevation of the streambed and shall be backfilled with suitable heavy material to the preconstruction bottom elevation. Where the cable, encasement, or pipeline is placed in rock, a minimum depth of one foot from the lowest point in the natural contour of the streambed shall be maintained. When crossing a maintained navigation channel, the requirements are a minimum of eight feet between the top of the cable, encasement, or pipeline and the authorized depth of the navigation channel. For maintained navigational channels, where the utility line is placed in rock, a minimum depth of two feet from the authorized depth of the navigation channel shall be maintained.
- c. As-Built Drawings: Within 60 days of completing an activity that involves an aerial transmission line, submerged cable, or submerged pipeline across a navigable water of the United States (i.e., Section 10 waters), the permittee shall furnish the Corps and National Oceanic and Atmospheric Administration, Nautical Data Branch, N/CS26, Station 7317, 1315 East-West Highway, Silver Spring, Maryland, 20910 with professional, certified as-built drawings, to scale, with control (i.e., latitude/longitude, state plane coordinates), depicting the alignment and minimum clearance of the aerial wires above the mean high water line at the time of survey or depicting the elevations and alignment of the buried cable or pipeline across the navigable waterway.

d. Aids to Navigation: The permittee must prepare and provide for USCG approval, a Private Aids to Navigation Application (CG-2554). The application can be found at: [https://media.defense.gov/2017/Nov/20/2001846135/-1/-1/0/CG\\_2554.pdf](https://media.defense.gov/2017/Nov/20/2001846135/-1/-1/0/CG_2554.pdf). The completed application must be sent to the appropriate USCG office as indicated below:

- i. Baltimore/Philadelphia Districts: Commander Fifth Coast Guard District, 431 Crawford Street, Room 100, Portsmouth, VA 23704-5504, Attn: Mr. Matthew Creelman; by email to [Matthew.K.Creelman2@uscg.mil](mailto:Matthew.K.Creelman2@uscg.mil); or by FAX to (757) 398-6303.
- ii. Pittsburgh District: Eighth Coast Guard District, Sector Ohio Valley, USCGC Osage, 300 McKown Ln, Sewickley, PA 15143; phone (412) 741-1180

Within 30 days of the date of receipt of the USCG approval, the permittee must provide a copy to the appropriate Corps district office.

27. PADEP Waiver: If the Corps determines a specific activity, which is eligible for a PADEP Non-reporting Waiver, has a significant adverse impact on life, property or important aquatic resources, the Corps may require the owner to modify the activity to eliminate the adverse condition or to obtain a Corps Individual Permit. In accordance with 33 CFR 325.7(a), "The District Engineer may reevaluate the circumstances and conditions of any permit, including regional permits, either on his own motion, at the request of the permittee, or a third party, or as the result of periodic progress inspections, and initiate action to modify, suspend, or revoke a permit as may be made necessary by considerations of the public interest. In the case of regional permits, this reevaluation may cover individual activities, categories of activities, or geographic areas."
28. Corps Water Releases: For projects located downstream of a Corps dam, the permittee should contact the appropriate Corps, Area Engineer Office, to obtain information on potential water releases and to provide contact information for notification of unscheduled water releases. It is recommended that no in-water work be performed during periods of high-water flow velocities. Any work performed at the project site is at the permittee's own risk.
29. State Authorization: The activity must receive state authorization. For the purpose of this requirement, any one of the following is considered as a state authorization:
  - a. A PADEP Chapter 105 Water Obstruction and Encroachment Permit, including PADEP approved Environmental Assessment pursuant to 25 Pa. Code § 105.15; or
  - b. A PADEP GP issued pursuant to 25 Pa. Code § §105.441-105.449; or
  - c. A PADEP approved Environmental Assessment for activities not otherwise requiring a PADEP permit pursuant to 25 Pa. Code § 105.12; or
  - d. A PADEP Dam Permit, including maintenance or repairs of existing authorized dams, including maintenance dredging; or

- e. A PADEP Emergency Permit issued pursuant to 25 Pa. Code § 105.64; or
  - f. A PADEP permit for the construction of a bridge or culvert which allows for maintenance activities of bridges and culverts; or
  - g. A PADEP Chapter 105 Dam Safety and Encroachment Enforcement Action.
30. Other Authorizations: Additional federal, state, and/or local authorizations or approvals may be required and where applicable must be secured by the applicant, prior to initiating any discharge of dredged and/or fill material, and/or the placement of structures into waters of the United States, including jurisdictional wetlands. These approvals include, but are not limited to:
- a. A project specific 401 SWQC issued by PADEP or considered waived, consistent with Section 401 of the CWA.
- PADEP has issued 401 SWQC for activities authorized by PASPGP-6 with conditions. See General Condition 2 for conditions and for identification when a project specific 401 SWQC or a waiver thereof is required. If the permittee cannot comply with all of the conditions of the 401 SWQC previously issued for PASPGP-6, then the permittee must obtain a project specific 401 SWQC or waiver for the proposed discharge in order for the activity to be authorized by PASPGP-6. The Corps or certifying authority may require additional water quality management measures to ensure that the authorized activity does not result in more than minimal degradation of water quality; and
- b. Reporting Activities located within the designated CZM Areas. Require a CZMA consistency determination issued by PADEP or a presumption of concurrence pursuant to Section 307 of the Federal Coastal Zone Management Act.
- The District Engineer or PADEP may require additional measures to ensure that the authorized activity is consistent with state CAM requirements; and
- c. Fills within the 100-year floodplains. This activity must comply with applicable Federal Emergency Management Agency approved state or local floodplain management requirements.
31. Federal Liability: In issuing this permit and any subsequent activity verification, the federal government does not assume any liability, including but not limited to the following:
- a. Damages to permitted project or users, thereof, as a result of other permitted or unpermitted activities or from natural causes;
  - b. Damages to the permitted project or uses, thereof, as a result of current or future activities undertaken by or on behalf of the United States in the public interest;
  - c. Damages to persons, property, or to other permitted or unpermitted activities or structures caused by the activity authorized by this permit;

- d. Design or construction deficiencies associated with the permitted work; and
- e. Damage claims associated with any future modification, suspension, or revocation of the PASPGP-6.

32. False and Incomplete Information: The Corps may modify or rescind a previously issued project specific verification, if it determines that the original verification was issued based on false, incomplete and/or inaccurate information; or other information becomes available whereby such action is necessary to ensure compliance with other federal laws and regulations.

33. Anadromous Fish Waters: To protect anadromous fish during their migration and spawning, no work can take place in the following anadromous fish waterways listed in the table below from March 15 to June 30 unless approved in writing by the Corps. Questions on the applicability of this condition should be directed to the Corps, Philadelphia District.

<u>Waterway</u>	<u>Downstream extent</u>	<u>Upstream extent</u>	<u>Upstream Latitude (N)</u>	<u>Upstream Longitude (E)</u>
<u>Delaware River in Pennsylvania (including W. Branch)</u>	<u>Rte. 220 Bridge</u>	<u>PA/NY Border</u>	<u>41.999448</u>	<u>-75.359573</u>
<u>Lehigh River and adjacent canals</u>	<u>confluence with Delaware River</u>	<u>500 feet upstream of the Cementon Dam</u>	<u>40.690275</u>	<u>-75.503800</u>
<u>Little Lehigh Creek</u>	<u>confluence with Lehigh River</u>	<u>500 feet upstream of the lowermost dam</u>	<u>40.596318</u>	<u>-75.475570</u>
<u>Hokendauqua Creek</u>	<u>confluence with Lehigh River</u>	<u>State Route 4014 (West Scenic Drive)</u>	<u>40.793273</u>	<u>-75.439262</u>
<u>Bushkill Creek</u>	<u>confluence with Delaware River</u>	<u>500 feet upstream of the lowermost dam</u>	<u>40.694859</u>	<u>-75.212406</u>
<u>Waterway</u>	<u>Downstream extent</u>	<u>Upstream extent</u>	<u>Upstream Latitude (N)</u>	<u>Upstream Longitude (E)</u>
<u>Brodhead Creek</u>	<u>confluence with Delaware River</u>	<u>500 feet upstream of the Stroudsburg Water Co. Dam</u>	<u>41.018667</u>	<u>-75.201063</u>
<u>Bush Kill</u>	<u>confluence with Delaware River</u>	<u>500 feet upstream of Resica Falls</u>	<u>41.111235</u>	<u>-75.095824</u>
<u>Lackawaxen River</u>	<u>confluence with Delaware River</u>	<u>500 feet upstream of the Woolen Mill Dam</u>	<u>40.984304</u>	<u>-75.191569</u>
<u>Dyberry Creek</u>	<u>confluence with Lackawaxen River</u>	<u>Jadwin Dam</u>	<u>41.612088</u>	<u>-75.263391</u>
<u>Darby Creek</u>	<u>Confluence with Delaware River</u>	<u>500 feet upstream of the confluence of Cobbs Creek and Darby Creek</u>	<u>39.907278</u>	<u>-75.255432</u>


Schuylkill River	Fairmount Dam	500 feet upstream of the Bingaman St. Bridge in Reading, Pennsylvania	40.326411	-75.934417
Neshaminy Creek	Confluence with Delaware River	500 feet upstream of the lowermost dam	40.143369	-74.915828

34. Compliance Certification: Each permittee who receives a written PASPGP-6 verification letter from the Corps must provide a signed certification documenting completion of the authorized activity and implementation of any required compensatory mitigation. This certification should indicate if the success of any required permittee-responsible mitigation was completed in accordance with the permit conditions. If credits from a mitigation bank or in-lieu fee program are used to satisfy the compensatory mitigation requirements, the certification must include the documentation required by 33 CFR 332.3(1)(3) to confirm that the permittee secured the appropriate number and resource type of credits. The signature of the permittee is also required to certify the completion of the activity and mitigation. The completed certification document must be submitted to the District Engineer within 30 days of completion of the authorized activity or the implementation of any required compensatory mitigation, whichever occurs later.

35. Migratory Birds and Bald and Golden Eagles: The permittee is responsible for ensuring that an action authorized by PASPGP-6 complies with the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. The permittee is responsible for contacting the appropriate local office of the USFWS to determine what measures, if any, are necessary or appropriate to reduce adverse effects to migratory birds or eagles, including whether "incidental take" permits are necessary and available under the Migratory Bird Treaty Act or Bald and Golden Eagle Protection Act for a particular activity. The permittee should contact the appropriate local office of the USFWS to determine if such authorizations are required for a particular activity. Information on the conservation of migratory birds and Bald and Golden Eagles can be found at the following USFWS web site:  
<http://www.fws.gov/northeast/pafo/>

36. Migratory Bird Breeding Areas: Activities in waters of the United States, including jurisdictional wetlands, that serve as breeding areas for migratory birds must be avoided to the maximum extent practicable. Recommendations pertaining to the conservation of migratory birds can be found at the following USFWS web site:  
<http://www.fws.gov/northeast/pafo/>

By Authority of the Secretary of the Army:

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John T. Litz  
Colonel, U.S. Army  
Commander and District Engineer  
Baltimore District

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David C. Park  
Lieutenant Colonel, Corps of Engineers  
District Commander  
Philadelphia District



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Andrew J. Short  
Colonel, Corps of Engineers  
District Engineer  
Pittsburgh District