

PROJECT MANUAL

PROJECT NO. DGS C-0961-0044 PHASE 001

Contract No. DGS C-0961-0044 Phase 1.1 – General Construction
Contract No. DGS C-0961-0044 Phase 1.2 – HVAC Construction
Contract No. DGS C-0961-0044 Phase 1.3 – Plumbing Construction
Contract No. DGS C-0961-0044 Phase 1.4 – Electrical Construction

For

**DMVA-Biddle AGS-Building 237 Renovations
Biddle AGS
Horsham, Montgomery County, PA**

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

**Josh Shapiro, Governor
Reginald B. McNeil II, Secretary of General Services**



**Date: August 26, 2024
Construction Documents**

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SECTION 010100
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. Biddle AGS Building 237, Horsham, Pennsylvania

1.3 PROJECT DESCRIPTION

- A. Renovation of Building 237 for use as training facility for National Guard Readiness Unit. Work is to include:
- Removal and replacement of interior finishes, mechanical, plumbing and electrical systems.
 - Removal and replacement of exterior wall and roof assemblies and windows
 - Reconfiguration of Pre Manufactured building to create Multipurpose Room, Locker Room, Storage and Office.
 - Removal and replacement of Mechanical, Fire Protection, Plumbing, Electrical systems.
 - Installation of Security, Intrusion Detection Services.
 - Refer to Section 010300 "Base Bid Descriptions" for additional Base Bids.

1.4 CONTRACT DURATION

- A. The Construction Contract duration shall be **357** calendar days commencing on the date of the Initial Job Conference.
- B. Refer to Section 013100 for how the contract duration may be impacted by long lead-time materials and equipment.

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. Selective Demolition.
 2. New roof and metal panel assemblies.
 3. New interior finishes.
 4. New interior partitions
 5. New windows, storefront with laminated glass, low visibility coating and structural sealant
 6. New canopy.
 7. New concrete pad at entrance and Pump Room.
 8. Removal of slab and installation of new slab infill at waste oil tank,
 9. Removal of slab at acid neutralization tank, oil water separator and hydraulic pump and below slab piping to be removed install concrete slab infill.
 10. Install concrete slab at trenches created to remove below slab equipment.
 11. Remove and replace Manhole 1.
 12. Patch asphalt paving where new gas line is to be installed.
 13. Reseed grass where pads and landscaping removed.

14. Mill and install asphalt at parking area and driveways
15. Remove and install new bollards.

C. HVAC Construction (.2) Contract:

1. Removal and replacement of HVAC System

D. Plumbing Construction (.3) Contract:

1. Removal and replacement of plumbing fixtures.
2. Installation of gas line (by PECO)
3. Removal of acid neutralization tank, oil water separator and hydraulic pump below slab and backfill.

E. Electrical Construction (.4) Contract:

1. Removal and replacement of Electrical System
2. Provide data outlets and pathways for IT and AV. IT and AV installation by others

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. Audio Visual, IT installation.
- B. Natural gas line and meter by PECO

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 010300
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-0961-0044 PHASE1.1)

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.

2. Base Bid No. 2:

- a. Same as Base Bid No. 1, except add - - -
- b. Division 03:
- i. Level floor of Multipurpose Room 102, Locker Room 106, Entry Vestibule 101, and Storage 103, Supply Office with concrete topping.
 - ii. Install concrete pad for Portable Dock Equipment
 - iii. Install concrete Weapons Vault
- c. Division 06:
- i. Plastic Laminate Architectural Casework in Break Room 121
- d. Division 09:
- i. PVC wall Protection Multipurpose Room 102 (4 feet tall)
 - ii. Install non structural metal framing and install gwb on all partitions at Storage 103 and Supply Office 104
 - iii. Install gwb on inside face of exterior walls at Supply Office 104 and Storage 103
 - iv. Install acoustical ceiling panels (ACP) at Supply Office 104.
 - v. Paint interior gwb, structure and deck at Storage 103 and Supply Office 104
- e. Division 10:
- i. Wire cages in Storage Room 103.
- f. Division 11:
- ii. Portable Dock Equipment

3. Base Bid No. 3

- a. Same as Base Bid No. 2, except add
- b. Division 03:

- i. Install foundations for vertical supports for canopy
 - c. Division 05:
 - i. Install steel framing for canopy including vertical support
 - d. Division 07:
 - i. Install plywood sheathing, rigid insulation, metal soffit panels at Canopy.
 - ii. Cut metal panels and flash at additional exterior lights.
 - e. Division 09:
 - i. Replace FRP with Ceramic Wall Tile at Men's 117 and Women's 118.
 - f. Division 10
 - i. Add freestanding display case to Room 101
 - ii. Add dimensional metal signage mounted to top of canopy and building.
- 4. Base Bid No. 4
 - a. Same as Base Bid No. 3, except add:-
 - b. Division 08:
 - i. Install additional storefront window bay on North Elevation
 - b. Division 32
 - i. Mill and repave existing driveway and parking area. Add striping for parking.
 - ii. Replace existing stormwater pipe.
 - iii. Install stone pavers on concrete slab at main entrance.
 - iv.

B. HVAC CONSTRUCTION CONTRACT (DGS C-0961-0044 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. 1, except add
 - b. Division 23
 - i. Install RTU #4
 - ii. Install VAV s serving Storage 103 and Supply Office 104.
 - iii. Install ductwork and air terminal outlets and inlets at Storage 103 and Supply Office 104.
 - iv. Install hydronic piping at Storage 103 and Supply Office 104.
- 3. Base Bid No.3 Same as Base Bid No. 2
- 4. Base Bid No. 4 Same as Base Bid No. 3.

C. PLUMBING CONSTRUCTION CONTRACT (DGS C-0961-0044 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. 1.
- 3. Base Bid No. 3

- a. Same as Base Bid No. 2.
- 4. Base Bid No. 4
 - a. Same as Base Bid No. 3
- D. ELECTRICAL CONSTRUCTION CONTRACT (DGS C-0961-0044 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. 1, except add - - -
 - b. Division 26
 - i. Install light fixtures and associated wiring, circuits at Storage 103, Supply Office 104.
 - ii. Install power receptacles. wiring, circuits at Storage 103, Supply Office 104.
 - 3. Base Bid No. 3:
 - a. Same as Base Bid No. 2, except add - - -
 - i. Install additional exterior light fixtures and associated wiring, circuits.
 - ii. Install lighting, wiring and circuits at canopy.
 - 4. Base Bid No. 4
 - a. Same as Base Bid No. 3.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION

SECTION 010400
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-0961-0044PHASE1.1 General Construction (Lead Contractor)
- B. DGS C-0961-0044PHASE 1.2 HVAC Construction
- C. DGS C-0961-0044PHASE 1.3 Plumbing Construction
- D. DGS C-0961-0044PHASE 1.4 Electrical Construction
- E.

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: Egan Degafa
 - 2. Telephone Number: (717) 679-7172

1.6 LEAD PAINT

- A. All work is to be performed with the assumption that all painted surfaces are lead containing. Each Prime Contractor is responsible for following all required OSHA 1926.62 'Lead In Construction' standards when disturbing or impacting these painted surfaces during the course of the renovations, including but not limited to activities such as: cutting and patching, core drilling, penetration, anchoring, fastening, etc. The area(s) shall be visually clean upon completion of any of these activities.
 - 1. Action Plan: Contractor(s) shall submit an Action Plan that conforms to Paragraph 1.6.A.1-3 herein for approval at the Initial Job Conference, which specifically outlines details of means and methods to be used for each dust-generating activity involving lead-painted surfaces, erection of critical barriers and plastic sheeting for dust control, subsequent exposure assessment, personal protective equipment, hygiene and clean-up.
 - 2. Contractor(s) shall utilize means and methods that preclude dust generation to complete work that disturbs/impacts lead-containing paint (i.e., paint stripper, HEPA-assisted drills, etc.).

3. Contractor(s) shall ensure areas beyond work area are not contaminated, and shall immediately stop work and erect plastic sheeting to prevent the spread of dust, anytime means and methods inadvertently create dust.

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

- C. 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.
- B.

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 ____6 A.M. to ____6_ 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.

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. Provide a chain link fence around the staging area identified on the drawings.

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.

Southeast Regional Office
2 East Main Street
Norristown, PA 19401-4915
(484) 250-5900

Counties: Bucks, Chester, Delaware,
Montgomery, and Philadelphia

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 MANAGER OFFICE

- A. The Lead Contractor shall prepare a drawing of the DGS Construction Manager 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 feet *600 to 1,000 square feet, as agreed to by the Construction Regional Director or Construction Project Manager*, 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.
- C. Equipment: The Lead Contractor shall furnish, with the DGS Construction Manager 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, cleaning 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 include all required battery chargers, data cables (including HDMI), software, ect. to provide a fully integrated and functioning system.

[

1. 2 Desk(s) with swivel computer chair(s)
2. _____
3. _____ Plans rack(s), plan rack shall include required quantity of plan sticks to fully utilize the plan rack
4. 1 Plans table
5. 2 Four (4) drawer file cabinet(s)
6. _____
7. 3 Six (6') foot table(s)
8. _____ Minimum of 12 Chair(s) for conference room
9. _____ Clothes tree & closet with rod

10. _____ 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, preferably an HP model
11. _____
12. _____ Fire Extinguisher
13. _____ First-Aid Kit
14. _____ Water cooler, with hot and cold taps
15. _____
16. 4 Trash cans

IT Hardware/Peripherals:

17. 3 Wide Screen Computer monitor(s) - basis of design - Hewlett Packard ProDisplay, HDMI compatible.
18. 2 Keyboards – basis of design – Hewlett Packard
19. 3 HP USB-C Dock G5 for Laptops Docking station with all associated cables for connection of all peripheral devices.
20. 2 Mouse (2 ea.) - wireless, dual button and scroll wheel –
21. 1 55" High Definition LED flat panel monitor with wall mount bracket and remote. Monitor shall be network/wireless capable, 120Hz, 1080P.
22. _____ 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. 2 4'x3' white marker board with (2) sets of markers of standard color.
24. 2 12 Month Wall Calendar - 20"x30" - Basis of design AT-A-GLANCE, Model #PM4-28-17

Other Items:

25. _____
26. 1 Coffee Pot with all associated supplies
27. 1 Microwave
28. 1 Mini Refrigerator
29. 1 Flyswatter
- D. The DGS Construction Manager 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 [

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. Removal of existing roof and metal siding
 - b. Removal of portions of existing concrete floor slab
 - c. Completion of metal siding installation
 - d. Completion of roof installation
 - e. Completion of concrete slab and topping
 - f. Completion of site work.
 - g. Final Inspection – October 22, 2025
 - h. Occupancy – November 22, 2025
 - .
 - 2. HVAC Construction (.2) Contract:
 - a. Removal of existing AHUs and ductwork
 - b. For new boiler:
 - 1) Delivery.
 - 2) Installation.
 - 3) Start-up, testing, and commissioning.
 - c. Start/completion of the new boiler monitoring system
 - 3. Plumbing Construction (.3) Contract:
 - a. Installation of below slab sanitary piping.
 - b.

4. Electrical Construction (.4) Contract:

- a. Installation of below slab electrical conduits
- b. Completion of main distribution panel and transformers.

1.5 SEQUENCING OF CONSTRUCTION AND OTHER REQUIREMENTS

When the Work of this Project includes longer than industry standard lead-times for materials or equipment for which all other tasks on the Project Schedule become dependent, the Department may issue a notice of a temporary suspension of the Work. If temporarily suspended, the Contractor must notify the Department at least thirty (30) days prior to the delivery date of the materials or equipment. Upon such notice, the Department will terminate the suspension and direct resumption of the Work to occur on or about the delivery date. The Contractor, in consultation with the Department, will evaluate the length of time needed to complete the project and a non-compensatory Extension of Time Change Order may be submitted by the Prime Contractor(s), which the Department will review in accordance with the Administrative Procedures governing Extensions of Time. During the temporary suspension,

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION

SECTION 014000
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 requirement 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
BITUMINOUS PAVEMENT		
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
EARTHWORK¹		
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
CONCRETE		
Practice for Sampling Freshly Mixed Concrete. (5 cylinders/test) Perform air tests when sampling concrete. Perform slump tests and record temperature for all concrete deliveries.	ASTM C143, C1064, C231 or C173 or C138, C172, C31	For each mix, 1 test for each day of concreting or for each 50cy, whichever is greater. For non-structural concrete, 1 test for each 100cy is adequate.
Compressive Strength of Cylindrical Concrete Specimens	C39	
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	AWS D1.4; ACI 318: 3.5.2	
Inspection of concrete placement for proper application techniques	ACI 318: 5.9, 5.10	Continuous

DESCRIPTION OF TEST OR INSPECTION	REFERENCED STANDARD	QUANTITY OR FREQUENCY
CONCRETE CONTINUED		
Verification of slump flow and VSI as delivered to the site for self-consolidating grout	ACI 530	Continuous
MASONRY		
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
STRUCTURAL STEEL		
High Strength Bolting	AISC ASD or LRFD M2.5	Comply with current requirements of RCSC
Liquid Penetrant Examination	ASTM E165	Test 15% of critical field welds using _____ method [to be specified by structural engineer herein]
Guide for Magnetic Particle Examination	ASTM E709	
Practice for Ultrasonic Contact Examination of Weldments	ASTM E164	
Guide for Radiographic Examination	ASTM E94	

Footnotes:

1. Refer to Earthwork Section for additional details.

END OF SECTION

SECTION 014010
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

<u>REQ'D BY¹</u>	<u>DESCRIPTION OF TEST OR INSPECTION</u>	<u>REFERENCED STANDARD</u>	<u>IBC REFER- ENCE²</u>
	BITUMINOUS PAVING		
DGS	Field inspection of construction procedures		

REQ'D BY¹	<u>DESCRIPTION OF TEST OR INSPECTION</u>	<u>REFERENCED STANDARD</u>	<u>IBC REFER- ENCE²</u>
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	
	CONCRETE		
IBC	1. Inspection of reinforcing steel, including prestressing tendons, and placement	ACI 318: 3.5, 7.1-7.7	1913.4
IBC	2. Inspection of reinforcing steel welding, in accordance with Table 1704.3, Item 5b	AWS D1.4; ACI 318: 3.5.2	
IBC	3. 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	1911.5 1912.1
IBC	4. Inspection of anchors installed in hardened concrete	ACI 318: 3.8.6, 8.1.3, 21.2.8	1912.1
IBC	5. Verifying use of required design mix	ACI 318: Ch. 4, 5.2-5.4	1904.22, 1913.2, 1913.3
IBC	6. At the time fresh concrete is sampled to fabricate specimens for strength tests, perform slump and air content tests, determine the temperature of the concrete	ASTM C172, C31; ACI 318: 5.6, 5.8	
IBC	7. Inspection of concrete and shotcrete placement for proper application techniques	ACI 318: 5.9, 5.10	1913.6, 1913.7, 1913.8
IBC	8. Inspection for maintenance of specified curing temperature and techniques	ACI 318; 5.11-5.13	1913.9
IBC	9. Inspection of prestressed concrete: a. Application of prestressing forces b. Grouting of bonded prestressing tendons in the seismic-force-resisting system	ACI 318: 18.20 ACI 318: 8.18.4	
IBC	10. Erection of precast concrete members	ACI 318: Ch.16	
IBC	11. Verification of in-situ concrete strength, prior to stressing of tendons in post-tensioned concrete and prior to removal of shores and forms from beams and structural slabs.	ACI 318: 6.2	
IBC	12. Inspect formwork for shape, location and dimensions of the concrete member being formed.	ACI 318: 6.1.1	
DGS	Review Contractors' design mixes, Certificates of Compliance and material test reports		
DGS	Compressive Strength of Cylindrical Concrete Specimens ²	ASTM C39	
	MASONRY		

<u>REQ'D BY¹</u>	<u>DESCRIPTION OF TEST OR INSPECTION</u>	<u>REFERENCED STANDARD</u>	<u>IBC REFER-ENCE²</u>
DGS	Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry, Annex A7 Compressive Strength ⁶	ASTM C780	
DGS	Method of Sampling and Testing Grout ⁶	ASTM C1019	
	Level 2 Special Inspection		
IBC	1. Compliance with required inspection provisions of the construction documents and the approved submittals shall be verified	Art 1.5 ⁵	
IBC	2. Verification of f'_m and f'_{AAC} prior to construction and for every 5000 square feet during construction	Art. 1.4B ⁵	
IBC	3. Verification of proportions of materials in premixed or preblended mortar and grout as delivered to the site	Art. 1.5B ⁵	
IBC	4. Verification of slump flow and VSI as delivered to the site for self-consolidating grout	Art. 1.5B.1.b.3 ⁵	
IBC	5. The following shall be verified to ensure compliance: a. Proportions of site-prepared mortar, grout and prestressing grout for bonded tendons b. Placement of masonry units and construction of mortar joints c. Placement of reinforcement, connectors and prestressing tendons and anchorages d. Grout space prior to grouting e. Placement of grout f. Placement of Prestressing grout g. Size and location of structural elements. h. Type, size and location of anchors, including other details of anchorage of masonry to structural members, frames or other construction. i. Specified size, grade and type of reinforcement, anchor bolts, prestressing tendons and anchorages. j. Welding of reinforcing bars. k. Preparation, construction and protection of masonry during cold weather (temperature below 40°F) or hot weather (temperature above 90°F). l. Application and measurement of prestressing force.	Art 2.6A ⁵ Art 3.3B ⁵ Sec 1.15 ⁴ , Art 3.4, 3.6A ⁵ Art 3.2D ⁵ Art 3.5 ⁵ Art 3.6C ⁵ Art 3.3F ⁵ Sec.1.2.2(e), 1.16.1 ⁴ Sec. 1.15 ⁴ Art. 2.4, 3.4 ⁵ Sec. 2.1.9.7.2, 3.3.3.4 (b) ⁴ Art. 1.8C, 1.8 ⁵ Art. 3.6B ⁵	2104.3, 2104.4
IBC	6. Preparation of any required grout specimens and/or prisms shall be observed	Art 1.4 ⁵	2105.2.2 2105.3
	STEEL CONSTRUCTION		
IBC	1. Material verification of high-strength bolts, nuts, and washers: a. Identification markings to conform to ASTM standards spec in the approved CDs. b. Manufacturer's Certificate of Compliance required	AISC 360, Section A3.3 and applicable ASTM material standards	

<u>REQ'D BY¹</u>	<u>DESCRIPTION OF TEST OR INSPECTION</u>	<u>REFERENCED STANDARD</u>	<u>IBC REFER- ENCE²</u>
IBC	2. Inspection of high-strength bolting: a. Snug-tight joints b. Pretensioned and slip-critical joints using turn-of-nut with matchmarking, twist-off bolt or direct tension indicator methods of installation. c. 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)	AISC 360, Section M2.5	1704.3.3
IBC	3. Material verification of structural steel and cold-formed steel deck: a. For structural steel, identification markings to conform to AISC 360 b. For other steel, identification markings to conform to ASTM standards specified in the approved CDs c. Manufacturer certified test reports	AISC 360, Section M5.5 Applicable ASTM material standards	
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	
	COLD-FORMED STEEL TRUSSES		

<u>REQ'D BY¹</u>	<u>DESCRIPTION OF TEST OR INSPECTION</u>	<u>REFERENCED STANDARD</u>	<u>IBC REFER- ENCE²</u>
IBC	Cold-formed steel trusses spanning 60 feet or greater		1704.3.4
	SEISMIC RESISTANCE		
IBC	Professional to determine requirements.		1705, 1707, 1708
	WIND REQUIREMENTS		
IBC	Professional to determine requirements.		1706
	GENERAL OVERVIEW OF QC TESTING		
DGS	Review of Contractor QC Testing and Reports		

SECTION 2

<u>REQD BY¹</u>	<u>DESCRIPTION OF TEST OR INSPECTION</u>	<u>REFERENCED STANDARD</u>	<u>IBC REFER- ENCE²</u>
	SOILS		
IBC	1. Verify materials below shallow foundations are adequate to achieve the design bearing capacity		1704.7
IBC	2. Verify excavations are extended to proper depth and have reached proper material		1704.7
IBC	3a. Perform testing of compacted fill materials	ASTM D6938	1704.7
	3b. Perform classification of proposed compacted fill		1704.7
	3c. Perform Modified Proctor testing of proposed compacted fill	ASTM D1557	1704.7
	3d. Perform Standard Proctor testing of proposed compacted fill	ASTM D698	1704.7
IBC	4. Verify use of proper materials, densities and lift thicknesses during placement and compaction of compacted fill		1704.7
IBC	5. Prior to placement of compacted fill, observe subgrade and verify that site has been prepared properly		1704.7
	ENGINEERING SERVICES		
DGS	Review of Contractor QC Test Reports.		
DGS	Review of Contractor QC Soil Bearing Test Reports.		

<u>REQD BY¹</u>	<u>DESCRIPTION OF TEST OR INSPECTION</u>	<u>REFERENCED STANDARD</u>	<u>IBC REFER- ENCE²</u>
DGS	On-site Engineering Consultation ⁷		
DGS	Office Engineering Consultation ⁷		

Footnotes:

1. "DGS" are tests required by DGS and "IBC" are test required by Chapter 17 of the 2009 International Building Code.
2. IBC 2009.
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 015000
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, by means of the permanent water supply line, .
- B. The Plumbing Contractor will be required to provide a meter and RPZ back-flow preventer.
- C. The Lead Contractor shall pay all charges for water consumption, except for testing, as specified in Section 010400.

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.
- 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 **[60]** 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.

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 016350

DEPARTMENT OF MILITARY & VETERANS AFFAIRS– 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.

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 [Criminal History Bkgnd. Check \(pa.gov\)](http://pa.gov).
- 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 024116

STRUCTURE DEMOLITION

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 SUMMARYs

A. The Work of this Section Includes:

1. Demolition and removal of site improvements.
2. Abandoning in-place below-grade construction.
3. Removing below-grade construction.
4. Disconnecting, capping or sealing, and abandoning in-place site utilities.
5. Disconnecting, capping or sealing, and removing site utilities.

B. Related Requirements:

1. Section 011000 "Summary" for use of the premises and phasing requirements.
2. Section 013200 "Construction Progress Documentation" for preconstruction photographs taken before building demolition.
3. Section 024119 "Selective Demolition" for partial demolition of buildings, structures, and site improvements.
4. Section 311000 "Site Clearing" for site clearing and removal of above- and below-grade site improvements that are not part of building demolition.

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged.
- B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner as indicated. Include fasteners or brackets needed for reattachment elsewhere.

1.4 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 PREINSTALLATION MEETINGS

- A. Pre demolition Conference: Conduct conference at Project site
 1. Inspect and discuss condition of construction to be demolished.
 2. Review structural load limitations of existing structures.
 3. Review and finalize building demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 4. Review and finalize protection requirements.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Statements: For refrigerant recovery technician
- B. Engineering Survey: Submit engineering survey of condition of building.
- C. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed in accordance with EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.7 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

1.8 QUALITY ASSURANCE

- 1.9 Refrigerant Recovery Technician Qualifications: Universal certified by an EPA-approved certification program.

1.10 FIELD CONDITIONS

- A. Owner will not occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
 1. Before selective demolition, Owner will remove the following items:
 - a. Stored items
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials:

- E. On-site sale of removed items or materials is not permitted.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI/ASSP A10.6 and NFPA 241.

2.2 SOIL MATERIALS

- A. Satisfactory Soils: Comply with requirements in Section 312000 "Earth Moving."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting demolition operations.
- B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Engage a professional engineer to perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during building demolition operations.
- D. Verify that hazardous materials have been remediated before proceeding with building demolition operations.
- E. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs or video, measured drawings Comply with Section 013233 "Photographic Documentation."
 - 1. Inventory and record the condition of items to be removed and salvaged. Photograph or video conditions that might be misconstrued as damage caused by removal.
 - 2. Photograph or video existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by demolition operations or removal of items for salvage.

3.2 PREPARATION

- A. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations. Maintain exits from existing buildings.

- B. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.
 - 1. Strengthen or add new supports when required during progress of demolition.
- C. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction and as indicated. Comply with requirements in Section 015000 "Temporary Facilities and Controls."
 - 1. Protect adjacent buildings and facilities from damage due to demolition activities.
 - 2. Protect existing site improvements, appurtenances, and landscaping to remain.
 - 3. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
 - 4. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 5. Provide protection to ensure safe passage of people around building demolition area and to and from occupied portions of adjacent buildings and structures.
 - 6. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to building demolition operations.
 - 7. Erect and maintain dustproof partitions and temporary enclosures to limit dust, noise, and dirt migration to occupied portions of adjacent buildings.
- D. Existing Utilities to Remain: Maintain utility services to remain and protect against damage during demolition operations.
 - 1. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction.
 - 2. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and authorities having jurisdiction.
 - a. Provide at least 72 hours' notice to occupants of affected buildings if shutdown of service is required during changeover.
 - 3. Owner will arrange to shut off utilities when requested by Contractor.
 - 4. If disconnection of utility services will affect adjacent occupied buildings, then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
 - 5. Cut off pipe or conduit a minimum of 24 inches (610 mm)] below grade at or outside the building or structure to be demolished and cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing in accordance with requirements of authorities having jurisdiction.
 - 6. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing by authorities having jurisdiction.
- E. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment in accordance with 40 CFR 82 and regulations of authorities having jurisdiction.
- F. Site Access and Temporary Controls: Conduct building demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide

- alternates routes around closed or obstructed trafficways if required by authorities having jurisdiction.
 - 2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
- G. Explosives: Use of explosives is not permitted.

3.3 DEMOLITION BY MECHANICAL MEANS

- A. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
 - 1. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.
- B. Existing Utilities:
 - 1. Abandon existing utilities and below-grade utility structures. Cut utilities flush with grade.
 - 2. Demolish existing utilities and below-grade utility structures as indicated.
 - a. Fill abandoned utility structures with satisfactory soil materials in accordance with backfill requirements in Section 312000 "Earth Moving."
 - 3. Demolish and remove existing utilities and below-grade utility structures as indicated.

3.4 SITE RESTORATION

- A. Below-Grade Areas:
 - 1. Rough grade below-grade areas ready for further excavation or new construction.
 - 2. Completely fill below-grade areas and voids resulting from building demolition operations with satisfactory soil materials in accordance with backfill requirements in Section 312000 "Earth Moving."
- B. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

3.5 REPAIRS

- A. Promptly repair damage to adjacent buildings caused by demolition operations.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and recycle or dispose of them in accordance with Section 017419 "Construction Waste Management and Disposal."
 - 1. Do not allow demolished materials to accumulate on-site.

2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

- B. Do not burn demolished materials.

3.7 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by building demolition operations. Return adjacent areas to condition existing before building demolition operations began.

1. Clean roadways of debris caused by debris transport.

END OF SECTION 024116

SECTION 024119
SELECTIVE DEMOLITION

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.

1.1 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. Demolition and removal of selected portions of the building or structure.
 2. Provide all materials, labor, tools, equipment, transportation, design, supervision, and administration for erection and dismantling of a lined, scaffold-supported trash chute.
 3. Erection of temporary weather enclosures to prevent entry of rain and wind into the building following removal of existing roof construction.
-
1. Section "Scope of Work" for restrictions on use of the premises, Owner occupancy requirements, and phasing requirements.
 2. Section 260100 "Electrical Work General Requirements" for requirements and restrictions concerning demolition of electrical systems and preservation of service to remaining portions of facility.

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.
- C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

- E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.4 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.5 PREINSTALLATION MEETINGS

- A. Pre-demolition Conference: Conduct conference at Project site.
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review structural load limitations of existing structure.
 - 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
 - 5. Review areas where existing construction is to remain and require protection.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For refrigerant recovery technician.
- B. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers.
- C. Schedule of Selective Demolition Activities: Indicate the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
 - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Installation of debris chute.
 - 5. Use of elevator and stairs.
 - 6. Coordination of Owner's continuing occupancy of portions of existing building.
- D. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.7 ACTION SUBMITTALS

- A. Shop Drawings: Submit plans, elevations, sections and details of the following:
 - 1. Debris chute and scaffolding construction, including connection to building and supports on ground.

2. Temporary weather enclosures.
 3. Shoring of existing roof framing members.
- B. Calculations: Submit calculations prepared by a Calif-licensed professional engineer substantiating ability of the following to resist required loads:
1. Debris chute scaffolding member sizes and connecting fasteners.
 2. Framing of temporary weather enclosures.
 3. Roof shoring.
- C. Product Data: Submit for materials used in debris chute and temporary weather enclosure construction.

1.8 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

1.9 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.10 FIELD CONDITIONS

- A. Owner will occupy portions of building on floors immediately below selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
1. Before selective demolition, Owner will remove the following items:
 - a. Furnishings and equipment, unless otherwise noted.
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: Present in areas to be selectively demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
1. Hazardous material remediation is specified elsewhere in the Contract Documents.
 2. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
- E. Storage or sale of removed items or materials on-site is not permitted.

- F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

- 1. Maintain fire-protection facilities in service during selective demolition operations.

- G. Use of Elevators: Elevators shall be used for transport of working personnel only; no debris, construction materials or equipment shall be moved via elevators unless specifically approved by Owner.

1.11 COORDINATION

- A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ASSE A10.6 and NFPA 241.
- C. Design: Engineer debris chute & scaffolding support to withstand impact loads from use. Engineer debris chute scaffolding, temporary weather enclosures and roof shoring to withstand dead loads and anticipated external live loads of wind and seismic activity.
 - 1. Design temporary enclosure for the large opening in roof to be removable, allowing for building materials to be delivered to the floor level during construction phase, then replaceable at end of day's work.

2.2 DEBRIS CHUTE

- A. Scaffolding: System of galvanized steel components with bolted connections.
- B. Lining: Wood structural panels.

2.3 TEMPORARY WEATHER ENCLOSURES

- A. Framing: Galvanized steel studs and joists.
- B. Sheathing: Wood structural panels.
- C. Weather Barrier: Self-adhesive or fluid-applied membrane capable of remaining weather-tight against rain, wind and sun exposure for the required length of project schedule.

2.4 ROOF SHORING

- A. Strongbacks and sleepers: Hot-rolled structural steel shapes.
- B. Posts and columns: Steel pipe or HSS shapes.
- C. Bracing: Hot or cold-rolled channels or angles.
- D. Misc. plates or bars.
- E. Connections: Bolted or welded for steel-to-steel; drilled-in expansion anchors for steel to concrete.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been shut-off, disconnected and capped before starting selective demolition operations.
- B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

3.2 PREPARATION

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
 - 2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.

- c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
- d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
- e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
- g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.4 PROTECTION

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
 - 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 - 4. Protect elevator and dumbwaiter entrances, indicators and controls from damage. Repair or replace any components that are damaged to satisfaction of Owner.
 - 5. Comply with project requirements for temporary enclosures, dust control, heating, and cooling.
- B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
 - 1. Strengthen or add new supports when required during progress of selective demolition.
- C. Remove temporary barricades and protections where hazards no longer exist.

3.5 DEBRIS CHUTE ERECTION

- A. Setup debris chute in location indicated on drawings extending from ground to the floor level of the work.
- B. Carefully remove the window at the indicated location and save for reinstallation at completion of the work. Seal the debris chute to the surrounding opening against weather intrusion and dust/debris escape.
- C. Place roll-off debris container at bottom of chute. Coordinate with Owner to allow space for continued use of loading dock adjacent to debris container.

3.6 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable firesuppression devices during flame-cutting operations.
 5. Maintain fire watch during and for at least 2 hours after flame-cutting operations.
 6. Maintain adequate ventilation when using cutting torches.
 7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 10. Dispose of demolished items and materials promptly
- B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- C. Removed and Salvaged Items:
1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers.
 3. Store items in a secure area until delivery to Owner.
 4. Transport items to storage area designated by Owner.
 5. Protect items from damage during transport and storage.
- D. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse.
 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
 3. Protect items from damage during transport and storage.
 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.7 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.
- B. Concrete Roof Slabs-: Shore up below, saw-cut perimeter of area to be demolished, and then break up and remove.
- C. Metal Roof Deck and Framing: Saw cut opening of indicated size in location indicated for access opening to be used for delivery of building materials in new construction phase. Unbolt and remove indicated steel channel and Z purlins; save and store where directed by Owner for reinstallation in next phase of project.
- D. Roofing: Neatly cut and remove roofing and insulation where indicated to expose structural roof deck for further demolition.

3.8 INSTALLATION OF TEMPORARY WEATHER ENCLOSURES

- A. Install approved temporary weather enclosures at all openings created in exterior of building by demolition operations. Secure to building to withstand wind forces. Seal weather-tight.

3.9 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and dispose of them in an EPA approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 - 3. Remove debris from demolition area via debris chute, to grade level in a controlled descent.
- B. Burning: Do not burn demolished materials.

3.10 REMOVAL OF TEMPORARY ELEMENTS

- A. Structure Shoring: Coordinate removal of shoring members and fastenings from site with Owner's interior improvement phase schedule when notified that permanent construction is self-supporting.
- B. Disassemble and remove from site the debris chute and scaffolding when no longer needed for removal of construction waste during the Owner's interior improvement phase. Scheduled term for use of debris chute will be as indicated in Contract General Requirements.
- C. Leave temporary weather enclosures in place. Owner will disassemble and dispose of when replaced with permanent construction.

3.11 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 024119

SECTION 026500

UNDERGROUND STORAGE TANK REMOVAL – ABANDONMENT

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 RELATED WORK SPECIFIED ELSEWHERE

- A. Earth Moving: Section 312000.
- B. Erosion and Sediment Control: Section 312500.

1.03 SUBMITTALS

- A. Removal procedures and schedule.
- B. Plan of Operations:
 - 1. Include, at a minimum, a description of project approach covering methods for sampling, analysis, removal and disposal of all waste. Additionally, the Plan of Operations shall include:
 - a. Description of soil removal methods to be employed; including excavation protection.
 - b. Description of a method for the decontamination of the excavator bucket prior to the procurement of soil samples at the completion of principal excavation work in each tank area.
 - c. Description of the waste segregation and staging methods to be used for soils, poly sheeting, and spent personal protective equipment.
 - d. Methods to be used for dewatering.
 - e. Methods to be used for cleaning of tank and piping.
 - f. Methods to be used for placement and compaction of backfill materials.
 - g. Identification of all waste transporters and disposal facilities including copies of all required certifications and permits.
 - h. Description methods to be employed to prevent storm water pollution from staged petroleum-contaminated soil, if encountered.
 - i. Required certifications and permits including copies of valid permits for all waste haulers, disposal sites, and weigh scales.
 - 1. Submit at a minimum of two (2) weeks prior to commencing work.
 - 2. Waste shall include, but not be limited to tank, piping, ballasts, concrete pad, tank contents, wash water, soils, samples, and used personal protective equipment.
- D. Copy of notifications to the Pennsylvania Department of Environmental Protection (PADEP), informing the Department of the planned closure and removal of the tank.

- E. Record Documents:
 - 1. Completed waste manifests (or bill of lading for non-hazardous materials) as described herein, accounting for all materials removed from the site.
- F. Health and Safety Plan, (HASP): Including regulations for confined space entry (29 CFR 1910.146) and other applicable portions of 29 CFR 1926, that addresses exposure of workers to residual product and accumulated sludge that may need to be removed from the tanks.
 - 1. The Director's Representative will review and comment on the HASP but will neither approve nor disapprove it.
- G. Confined Space Entry Permit and the worker training certificates required to clean out the tank once it is excavated.
- H. Quality Control Submittals:
 - 1. Excavation Procedure: Submit a layout drawing or detailed outline of intended excavation procedure for the Director's information.
 - 2. This submittal will not relieve the Contractor of responsibility for the successful performance of intended excavation methods.
- I. Manifests: Contractor shall submit copies of all load tickets and manifests, if applicable. Certification of destination, receipt, and disposal of demolition materials must also be submitted.
- J. Landfill or scrap yard records indicating receipt and acceptance of UST and any contaminated soil by a landfill facility licensed to accept such materials.
- K. UST Closure Report: Furnished by Environmental Consultant, which will be coordinated by the Director's Representative.

1.04 REQUIRED CERTIFICATIONS AND LICENSES

- A. Employees involved in hazardous waste operations shall have been trained in accordance with OSHA Final Standards to Protect Workers in Hazardous Waste Operations 29 CFR 1910.120 or most recent revision thereof.
- A. Waste haulers shall maintain a valid PADEP Permit.

1.05 REGULATORY REQUIREMENTS

- A. Abide by all applicable rules and regulations, including but not limited to the following:
 - 1. Pennsylvania Fire Prevention and Building Code.
 - 2. Pennsylvania Department of Environmental Protection Storage Tank Closure Regulations.
 - 3. American Petroleum Institute, Recommended Practice 1604, Second Edition, December, 1987, "Removal and Disposal of Used Underground Petroleum Storage Tanks", and revisions thereof.
 - 4. Federal Underground Storage Tank (UST) Regulations, 40 CFR Part 280.
 - 5. Applicable OSHA worker safety regulations.
 - 6. State, county, and federal regulations pertaining to the handling, storage, transport, and disposal of wastes generated during the project.
 - 7. Coordinate and obtain all permits as required by permitting authorities.

1.06 ABBREVIATIONS

- A. The following terms shall have the meanings ascribed to them in this Section, wherever they appear in this Section.

1. API: American Petroleum Institute.
2. FRP: Fiberglass-Reinforced Plastic.
3. NFPA: National Fire Protection Association.
4. OSFM: Office of the State Fire Marshal.
5. OSHA: Occupational Safety and Health Administration.
6. PADEP: Pennsylvania Department of Environmental Protection
7. PennDOT: Pennsylvania Department of Transportation
8. PBS: Petroleum Bulk Storage.
9. USEPA: United States Environmental Protection Agency.
10. UST: Underground Storage Tank.
11. HASP: Health and Safety Plan.

1.07 NOTIFICATION

- A. In accordance with PADEP Underground closure Checklist, the Director's Representative will notify Pennsylvania Department of Environmental Protection (PADEP) thirty (30) days prior to permanent closure of the tank.
- B. Notify (by telephone) the Director's Representative at least 48 hrs prior to beginning closure operations at the tank.
- C. If contaminated soils are encountered, the Director's Representative will notify the PADEP Spills Hotline.

1.08 EXISTING CONDITIONS

- A. Protect and safeguard from damage all existing structural systems, fencing, equipment, and surfaces that will remain. Contractor Repair any damage to structures, appurtenances or the landscape not scheduled for removal work.

1.09 ENVIRONMENTAL OVERSIGHT

- A. The Director's Representative will secure the services of an authorized Environmental Consultant to act on his behalf for field observation and to provide analysis of wastes destined for disposal.
- B. The Environmental Consultant will advise the Director's Representative on environmental matters.
1. Such advisement does not relieve the Contractor's obligation to comply with all applicable environmental and health and safety regulations promulgated by the federal, state, or local governments.
 2. No activity on the part of the Environmental Professional represents the Contractor's compliance with applicable environmental or health and safety regulations.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Tank Fill Material: Weak sand/cement mixture with final compressive strength of +/-100 psi. Mixture shall have ability to flow freely up to all parts of tank and set firmly using all mixing

water, and leaving no voids or areas where ponding can occur.

B. CONCRETE CEMENT MIXTURE

1. Basis of Design: K-Krete
 - a. 9072 CR 424
 - b. Napoleon, OH 43545
 - c. Ph: (419) 533-7701
 - d. <https://gerkencompanies.com/>
2. Quikrete
 - a. 5 Concourse Parkway, Suite 1900
 - b. Atlanta, GA 30328
 - c. 404-634-9100
 - d. <http://www.quickrete.com>
3. Sakrete
 - a. 1214 Hayes Blvd, Bristol, PA 19007
 - b. Ph: 1(866) 824-7446
 - c. <https://www.sakrete.com/>
4. Or equal as approved by design professional.

PART 3 EXECUTION

3.01 PREPARATION

- A. Contact the Pennsylvania Department of Environmental Protection (PADEP) Regional Office at least 30 business days prior to the removal of the underground petroleum storage tanks.
- B. Locate and clearly mark all subsurface utilities in the area of excavation. Conduct activities to minimize interference with, and to protect the existing surfaces of, adjacent structures or utilities.
- C. Provide, erect, and maintain temporary barriers and security devices.
- D. Conduct operations with minimum interference to public or private thoroughfares. Do not close or obstruct drive areas or sidewalks without permits.
- E. Prevent movement or settlement of adjacent structures. Provide bracing and shoring.
- F. Remove and dispose of abandoned conduit or piping within excavated areas and plug ends.
 1. Identify disconnection locations on Project Record Documents.
- G. Perform tank removal in a manner that will minimize dust, noise, and other nuisance. Maintain haul routes for disposal of material clean and free of debris.
- H. Provide monitoring equipment at site as required by the Site Health and Safety Plan. Operate and maintain in accordance with manufacturer's recommendations.
- I. Perform the Work with consideration for facility personnel and the public. Maintain barriers between work areas and adjacent facilities at all times, with necessary signs, lights, bracing and guards for the protection of all facility personnel, the public, and existing facilities.
- J. Schedule the Work in advance with the Director's Representative to coordinate work

schedules.

- K. Notify the Director's Representative minimum of 30 days in advance of tank removal or abandonment.
 - 1. Alternative arrangements must be approved in writing by the Director's Representative.
 - 2. The Director's Representative will arrange and pay for a certified Pennsylvania state testing laboratory to analyze samples of soils, liquids, sludges and ground water destined for disposal.

3.02 UNDERGROUND STORAGE TANK LIQUID REMOVAL

- A. Prior to excavation around the UST, empty the tank as follows:
 - 1. Remove all product to its lowest draw-off point.
 - 2. Drain and flush piping into the tank (one or two gallons of water should be sufficient).
 - 3. Pump out the liquid below the draw-off point (tank bottom).
 - a. Use an explosion-proof hand or vacuum pump.
 - b. Approximately 6" of liquid remains in the tank below the lowest draw-off point; this is equivalent to 150 gallons for a typical 4,000-gallon tank.
 - c. Pump out the entire tank bottom including the remaining product layer.
 - 4. Bond equipment to tank and ground tank to a separate ground when purging tank with compressed air or inert gas under pressure.
 - 5. Turn over product removed from tank to the State as directed by Director's Representative.
 - a. If contents are to be disposed, tank contents shall be properly disposed of in accordance with PADEP, PennDOT and local regulations.
 - b. Provide proof of proper disposal to Environmental Consultant and Director's Representative.

3.03 UNDERGROUND TANK AND PIPING REMOVAL

- A. Inert the interior atmosphere before extracting the tank from its location.
- B. Excavate to the top of the tank and stockpile soil as specified in Section 312000, Earth Moving. In the event contaminated soil and/or groundwater is discovered remove and temporarily stockpile the material as specified herein this Section.
- C. Excavation around existing UST:
 - 1. Dig down to expose upper half of tank. During excavation, exercise extreme caution in order to maintain the integrity of the UST.
 - 2. Perform excavation in the presence of the Director's Representative who will check material for possible contamination using a organic vapor meter (OVM). Place excavated material in a separate stockpile as directed, pending disposal.
- D. Disconnect suction, inlet, gauge and all other tank fixtures, except the vent line.
- E. Temporarily plug all tank openings, complete the excavation, and remove the tank, placing it in a secure location. Tank must be blocked to prevent movement.
- F. Spills or drips shall be contained to prevent contamination of soils during removal.
- G. Excavate to uncover existing piping associated with the tank.

1. Remove all underground piping.
 2. Do not rupture tank or pipelines.
 3. Pipe trenches shall remain open for inspection by Director's Representative.
- H. Backfill the tank and pipe excavations with clean Type 2 fill material, compact, grade, place topsoil and seed or pavement to restore area to original condition. Refer to Section 312000.
- I. Cease operations and notify the Director's Representative immediately if adjacent structures appear to be endangered. Do not resume operations until corrective measures are taken, and written approval is received by the Director's Representative.
- J. Except where noted otherwise, immediately remove demolished material from site.
- K. Do not burn or bury materials on site.
- L. Excavate, segregate, stockpile, and protect soils with evidence of possible petroleum contamination (by visible staining, odors, or by the readings on the Environmental Consultant's field instrumentation) in accordance with applicable PADEP guidance.
1. Such soils shall be placed on poly sheeting (6-mil minimum) bermed to prevent run-off, covered with same type of poly to keep precipitation off of the staged soil, and the cover shall be secured to keep the pile dry.
- M. Remove and properly dispose of all tank fluids. Remove underground tank, components, and piping.
- N. Clean tank, components, and piping in accordance with applicable regulations and remove tank, components, and piping from site.
- O. Assist the Environmental Consultant with sampling of soils in the proximity of the tanks in accordance with applicable PADEP guidance. Provide excavator with bucket for gathering samples; decontaminate bucket prior to collecting each sample.
- P. Backfill and compact areas excavated for removal of tanks and appurtenances, in accordance with Section 312000 Earth Moving. Backfill additional areas excavated to remove petroleum-contaminated soils, as directed by the Director's Representative.
- Q. Rough grade, and compact areas affected by underground storage tank removals and resurface in accordance with Section 312000 Earth Moving.
- R. Dispose of removed materials from the site as Work progresses. Leave site in clean condition.
- S. Dispose of all wastewater off-site in accordance with applicable federal, state, and local regulations.
- T. Stockpile petroleum-contaminated soil encountered during the work.
- U. Coordinate with the Director's Representative and Environmental Consultant in providing soil samples for lab testing and analysis by Environmental Consultant.
- V. Submit waste disposal documents. Organize and index records, and include the following:
1. Waste characterization and waste profiles submitted to each permitted disposal facility. Include documentation of waste stream acceptance by the disposal facility.

2. Bills of lading or receipts or certifications and weigh tickets generated during the handling and disposal process.
3. Copies of all written approvals from duly authorized persons and agencies for the discharge of wastewater, where allowed, into storm or sanitary sewer systems, onto the ground, or into the groundwater.
4. Copies of 6 PADEP permits for waste haulers used in the work, with a separate listing of the material hauled by each entity listed and the final disposal locations of each waste material removed from the site.

3.04 UST CLEANING

- A. Conduct tank cleaning procedures in accordance with PADEP guidance documents and API Recommended Practice 1604.
- B. Measure levels of combustible vapors and oxygen with a Combustible Gas Indicator (CGI), and initiate ventilation of the tank, if needed:
 1. Ventilate tank using a small gas exhauster until the vapor concentration is reduced to 10 percent or less of the lower explosive limit (LEL).
 2. Oxygen content shall range from 19.5 to 23.5 percent.
- C. Ensure final vapor and oxygen concentrations are within the requirements noted above before proceeding to cut and dismantle the tank for its disposal.
 1. Methods for ensuring the tank has been made safe are outlined in Section 7 of PADEP's guidance document "Storage Tank Closure."
- D. Cut openings in tank to facilitate tank cleaning after vapor and oxygen concentrations have been met.
 1. Total surface area of holes cut into tank shall be minimum of 2% of total surface area of tank, or a minimum of 9 square feet each opposite side or end.
 2. Maintain a minimum of two fire extinguishers on-site during cutting of tank.
- E. Perform tank cleaning activities twenty-four (24) hours of tank removal from excavation site.
- F. Tank Cleaning: Include mopping, scraping and sweeping the interior of the tank. If applicable, comply with OSHA's confined space entry regulations.
- G. Collect, contain and place residuals in a United States Department of Transportation approved drum for transporting and disposal.

3.05 TANK ABANDONMENT

- A. Comply with Environmental Protection Agency regulations, and Department of Environmental Conservation regulations.
- B. Pump out all flammable liquid and drain and flush piping into tank.
- C. Remove tank bottoms and any remaining product from tank.
- D. Remove fill pipe and disconnect all piping connections to tank. Cap or plug open ends of piping which will not be reused. Do not disconnect vent line until abandoned tank has been filled with tank fill material.

- E. Purge tank of flammable vapors and cut large opening in top of tank.
- F. Clean tank with high pressure rinse using as little water as possible.
- G. Fill tank with tank fill material, and disconnect vent line.

3.06 CONTAMINATED MATERIAL DISPOSAL DOCUMENTATION

- A. Submit contaminated material disposal documentation prior to payment of any units involving disposal of contaminated materials.

3.07 DISPOSAL OF TANKS AND PIPING

- A. Dispose of tanks and all removed appurtenances from the premises as quickly as possible, preferably the same day as removed from the excavation.
- B. Legally dispose or recycle the removed tanks and appurtenances in accordance with all local, State and Federal regulations.
- C. Obtain disposal facility receipts noting proper tank and cleaning material disposal. Submit receipts to the Director's Representative.

END OF SECTION

SECTION 030130

MAINTENANCE OF 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" 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. Patching mortar.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site
 - 1. Review methods and procedures related to concrete work, including, but not limited to, the following:
 - a. Verify concrete-maintenance specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
 - b. Materials, material application, sequencing, tolerances, and required clearances.
 - c. Quality-control program.

1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of product.
 - a. Include construction details, material descriptions, chemical composition, physical properties, test data, and mixing, preparation, project application types consisting of horizontal, vertical or overhead locations and application instructions.
 - 2. Include sets of patching-material Samples in the form of briquettes, at least 3 inches (75 mm) long by 1-1/2 inches (38 mm) wide
- B. Samples for Verification: Cured Samples for each exposed product and for each color and texture specified.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Copy of Certificate of Approved concrete-maintenance specialist by manufacturer
- B. Material Certificates: For each type of cementitious patching mortar supplied for mixing or adding to products at Project site.
- C. Product Data Sheets: For each cementitious patching mortar.
- D. Safety Data Sheets: For each cementitious patching Mortar
- E. Field quality-control reports.
- F. Quality-Control Program: Submit before work begins.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Each packaged patching-mortar manufacturer must employ factory-authorized service representatives who are available for consultation and Project-site inspection and on-site assistance.
- B. Concrete-Maintenance Specialist Qualifications: Engage an experienced concrete-maintenance firm that employs installers and supervisors who are trained and approved by manufacturer to apply packaged patching-mortar when performing the Work of this Section. Contractor shall be qualified in the field of concrete repair and protection with a successful track record of 5 years or more. Contractor shall maintain qualified personnel who have received product training by a manufacturer's representative.
- C. Store and apply materials in accordance with all safety and weather conditions required by manufacturer or as modified by applicable rules and regulations of local, state, and federal authorities having jurisdiction. Consult Safety Data Sheets (SDS) for complete handling recommendations.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's written instructions for minimum and maximum temperature requirements and other conditions for storage.
- B. All materials must be delivered in original, unopened containers with the manufacturer's name, labels, product identification, and batch numbers. Damaged material must be removed from the site immediately.
- C. All materials must be delivered in original, unopened containers with the manufacturer's name, labels, product identification, and batch numbers. Damaged material must be removed from the site immediately.
- D. Store cementitious materials off the ground, under cover, and in a dry location.
- E. Store aggregates covered and in a dry location; maintain grading and other required characteristics and prevent contamination.

1.8 FIELD CONDITIONS

- A. All materials must be delivered in original, unopened containers with the manufacturer's name, labels, product identification, and batch numbers. Damaged material must be removed from the site immediately.
- B. All materials must be delivered in original, unopened containers with the manufacturer's name, labels, product identification, and batch numbers. Damaged material must be removed from the site immediately.

1.9 WARRANTY

- A. Provide a written warranty from the manufacturer against defects of materials for a period of one (1) year, beginning with date of substantial completion of the project.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. For repair products, obtain each color, grade, finish, type, and variety of product from single source and from single manufacturer with resources to provide products of consistent quality in appearance and physical properties.

2.2 PATCHING MORTAR

- A. Patching Mortar Requirements:
 - 1. Only use patching mortars that are recommended by manufacturer for each applicable horizontal, vertical, or overhead use orientation.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Sika ; SikaQuick-1000 Overlay (Basis-of-Design)
 - b. WR Meadows; Floor-Top STG
 - c. Or equal as approved by the Professional
- C. General
 - 1. The repair concrete shall be a blend of selected Portland cements, specially graded aggregates, admixtures for controlling setting time, and water reducers for workability and an organic accelerator.
 - 2. The materials shall be non-combustible, both before and after cure.
 - 3. The material shall be supplied as a factory-blended unit.
 - 4. The Portland cement mortar must be placeable from 1/4" to 1" in depth per lift for horizontal applications.
- D. To prepare a rapid-setting portland cement concrete: aggregate shall conform to ASTM C-33. The material shall be extended with 30-lb. of a 3/8" (No.8 distribution per ASTM C-33, Table II) clean, well-graded, saturated surface dry aggregate, having low absorption, high density and non-reactive (reference ASTM C-1260, C-227, C-289). Aggregate must be approved for use by the Engineer.

2.3 EPOXY CRACK-INJECTION MATERIALS

- A. Epoxy Crack-Injection Adhesive: ASTM C881/C881M, bonding system Type IV at structural locations and where indicated, Type I at other locations free of VOCs.
 - 1. Capping Adhesive: Product manufactured for use with crack-injection adhesive by same manufacturer.
 - 2. Products: Subject to compliance with requirements, products that may be incorporated into the work including the following:
 - a. Sika – Sikaflex (Basis of Design)
 - b. Sashco
 - c. Or equal as approved by the Professional

2.4 SEALERS

- A. Epoxy Polymer Sealer: Low-viscosity epoxy, penetrating sealer and crack filler recommended by manufacturer for penetrating and sealing cracks in exterior concrete traffic surfaces; free of VOCs
 - 1. Products: Subject to compliance with requirements, products that may be incorporated into the work including the following:
 - a. Sika – SikaCem(Basis of Design)
 - b. Prosoco
 - c. W.R. Meadows
 - d. Or equal as approved by the Professional

2.5 MISCELLANEOUS MATERIALS

- A. Curing Materials: For ready-mixed concrete or packaged repair materials.
- B. Formwork Materials: Form-facing materials must comply with ACI 301 (ACI 301M) requirements.
- C. Water: Potable.
- D. Cleaning Agent: Commercial muriatic acid solution.

2.6 PERFORMANCE CRITERIA

Typical Properties of the mixed polymer-modified, portland cement mortar:

- | | |
|--------------------------|--|
| 1. Yield | 0.42 ft ³ per bag |
| 2. Color | Concrete gray |
| 3. Mixing Ratio | 4.5-5 pts per bag |
| 4. Density | 136 lbs/ft ³ (2.18 kg/l) |
| 5. Application Thickness | Neat: Min 1/4" (7 mm); Max 2 " (50 mm)
Extended: Min 1" (25 mm); Max 6 " (152 mm) |
| 6. Application Temp | Min 50°F (10°C) ; Max 86°F (30°C) |

7. Working Time	30 min.
8. Compressive Strength (ASTM C-109)	3 hours – 1,250 psi (8.6 MPa) 1 day – 4,000 psi (27.6 MPa) 7 day - 5,000 psi (34.5 MPa) 28 days - 7,000 psi (48.2 MPa)
9. Flexural Strength (ASTM C-293)	28 day – 1,000 psi (6.9 MPa)
10. Splitting Tensile Strength (ASTM C-496)	28 days - 500 psi (3.4 MPa)
11. Slant Shear (ASTM C-882 Modified)	28 days - 2,500 psi (17.2 MPa)
12. Permeability (ASTM C-1202)	28 days < 1,000 C
13. Shrinkage (157 Modified per ASTM C-928)	28 days - 0.06%
14. Modulus of Elasticity (ASTM C-469)	28 days - 4.6×10^6 psi
14. Freeze-Thaw Resistance (ASTM C-666)	98%

2.7 MIXES

- A. General: Mix products, in clean containers, in accordance with manufacturer's written instructions.
 1. Do not add water, thinners, or additives unless recommended by manufacturer.
 2. When practical, use manufacturer's premeasured packages to ensure that materials are mixed in proper proportions. When premeasured packages are not used, measure ingredients using graduated measuring containers; do not estimate quantities or use shovel or trowel as unit of measure.
 3. Do not mix more materials than can be used within time limits recommended by manufacturer. Discard materials that have begun to set.
- B. Mortar Scrub Coat: Mix dry ingredients with enough water to provide consistency of thick cream.

PART 3 - EXECUTION

3.1 EXAMINATION

3.2 PREPARATION

- A. Ensure that supervisory personnel are on-site and on duty when concrete-maintenance work begins and during its progress.
- B. Protect persons, motor vehicles, surrounding surfaces of building being repaired, building site, plants, and surrounding buildings from harm resulting from concrete-maintenance work.

1. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.
- C. Areas to be repaired must be clean, sound, and free of contaminants. All loose and deteriorated concrete shall be removed by mechanical means. Mechanically prepare concrete substrate to obtain a surface profile of $\pm 1/8"$ (CSP 6 or greater as per ICRI Guidelines) with a new exposed aggregate surface. Area to be patched shall not be less than 1" in depth.
- D. Where reinforcing steel with active corrosion is encountered, sandblast the steel to a white metal finish to remove all contaminants and rust. Where corrosion has occurred due to the presence of chlorides, the steel shall be high pressure washed after mechanical cleaning. Prime steel with 2 coats of Sika® Armatec® 110 EpoCem as per the Product Data Sheet (PDS).
- E.
1. Use water-mist sprinkling and other wet methods to control dust only with adequate, approved procedures and equipment that ensure that such water will not create a hazard or adversely affect other building areas or materials.
 2. Protect floors and other surfaces along haul routes from damage, wear, and staining.
- F. Existing Drains: Prior to the start of concrete-maintenance work in an area, test drainage system to ensure that it is functioning properly. Notify Architect immediately of inadequate drainage or blockage. Do not begin concrete-maintenance work in an area until the drainage system is in working order.
1. Prevent solids, such as aggregate or mortar residue, from entering the drainage system. Clean out drains and drain lines that become sluggish or blocked by sand or other materials resulting from concrete-maintenance work.
 2. Protect drains from pollutants. Block drains or filter out sediments, allowing only clean water to pass.
- G. Preparation for Concrete Removal: Examine construction to be repaired to determine best methods to safely and effectively perform concrete-maintenance work. Examine adjacent work to determine what protective measures will be necessary. Make explorations, probes, and inquiries as necessary to determine condition of construction to be removed in the course of repair.
1. Verify that affected utilities have been disconnected and capped.
 2. Inventory and record the condition of items to be removed for reinstallation or salvage.
 3. Provide and maintain shoring, bracing, and temporary structural supports as required to preserve stability and prevent unexpected or uncontrolled movement, settlement, or collapse of construction being demolished and construction and finishes to remain. Strengthen or add new supports when required during progress of removal work.
- H. Reinforcing-Bar Preparation: Remove loose and flaking rust from exposed reinforcing bars by high-pressure water cleaning until only tightly adhered light rust remains.
1. Where section loss of reinforcing bar is more than 25 percent, or 20 percent in two or more adjacent bars, cut bars and remove and replace as indicated on Drawings.
 2. Remove additional concrete as necessary to provide at least 3/4-inch (19-mm) clearance at existing and replacement bars.
 3. Splice replacement bars to existing bars in accordance with ACI 318 (ACI 318M) by lapping, welding, or using mechanical couplings.
 4. Remove delaminated material and deteriorated concrete surface material.

5. Roughen surface of concrete to produce a surface profile matching CSP 6-10 in accordance with ICRI 310.2.
 6. Use sand blasting
 7. Sweep and vacuum roughened surface to remove debris followed by low-pressure water cleaning
- I. Acidic Surface Preparation for Sealers: Acid etch surface of concrete to produce a surface profile matching CSP 1 in accordance with ICRI 310.2.[Prepare surface for acid etching by detergent scrubbing to remove oils and films that may prevent acid penetration.]
1. Remove excess acid solution, reaction products, and debris by squeegeeing or vacuuming.
 2. Scrub surface with an alkaline detergent, rinse, and squeegee or vacuum.
 3. Check acidity of surface with pH test paper and continue rinsing until pH is acceptable in accordance with sealer manufacturer's written instructions.
 4. When pH is acceptable in accordance with sealer manufacturer's written instructions and surface is clean, vacuum dry.

3.3 REMOVAL OF CONCRETE

- A. Do not overload structural elements with debris.
- B. Saw-cut perimeter of areas indicated for removal to a depth of at least [1/2 inch (13 mm)] Make cuts perpendicular to concrete surfaces and no deeper than cover on reinforcement.
- C. Remove deteriorated and delaminated concrete by breaking up and dislodging from reinforcement.
- D. Remove additional concrete if necessary to provide a depth of removal of at least [1/2 inch (13 mm)] < over entire removal area.
- E. Where half or more of the perimeter of reinforcing bar is exposed, bond between reinforcing bar and surrounding concrete is broken, or reinforcing bar is corroded, remove concrete from entire perimeter of bar and to provide at least 3/4-inch (19-mm) clearance around bar.
- F. Test areas where concrete has been removed by tapping with hammer, and remove additional concrete until unsound and disbonded concrete is completely removed.
- G. Provide surfaces with a fractured profile of at least 1/8 inch (3 mm) that are approximately perpendicular or parallel to original concrete surfaces. At columns and walls, make top and bottom surfaces level unless otherwise directed.
- H. Thoroughly clean removal areas of loose concrete, dust, and debris.

3.4 APPLICATION OF BONDING AGENTS

- A. Epoxy-Modified, Cementitious Bonding and Anticorrosion System: Apply to reinforcing bars and concrete by stiff brush or hopper spray in accordance with manufacturer's written instructions. Apply to reinforcing bars in two coats, allowing first coat to dry two to three hours before applying second coat. Allow to dry before placing patching mortar or concrete.
- B. is still wet. If bonding agent dries, recoat before placing patching mortar or concrete.

- C. Mortar Scrub Coat for Job-Mixed Patching Mortar and Concrete: Dampen repair area and surrounding concrete 6 inches (150 mm) beyond repair area. Remove standing water and apply scrub coat with a brush, scrubbing it into surface and thoroughly coating repair area. If scrub coat dries, recoat before placing patching mortar or concrete.

3.5 INSTALLATION OF PATCHING MORTAR

- A. Place patching mortar as specified in this article unless otherwise recommended in writing by manufacturer
 - 1. Provide forms where necessary to confine patch to required shape.
 - 2. Wet substrate and forms thoroughly and then remove standing water.
- B. Pretreatment: Apply specified [mortar scrub coat]
- C. mortar by troweling toward edges of patch to force intimate contact with edge surfaces. For large patches, fill edges first and then work toward center, always troweling toward edges of patch. At fully exposed reinforcing bars, force patching mortar to fill space behind bars by compacting with trowel from sides of bars.
- D. Multiple Lifts: Where multiple lifts are used, score surface of lifts to provide a rough surface for placing subsequent lifts. Allow each lift to reach final set before placing subsequent lifts.
- E. Finishing: Allow surfaces of lifts that are to remain exposed to become firm and then finish to a smooth surface with a wood or sponge float
- F. Curing: Wet-cure cementitious patching materials, including polymer-modified cementitious patching materials, for not less than seven days by water-fog spray or water-saturated absorptive cover.

3.6 CONCRETE PLACEMENT

- A. Place concrete in accordance with [Section 033000 "Cast-in-Place Concrete"] as specified in this article.
- B. Epoxy-Modified Pretreatment: Apply [epoxy bonding agent to reinforcement]
- C. Standard Placement: Place concrete by form-and-pump method unless otherwise indicated.
 - 1. Use vibrators to consolidate concrete as it is placed.
 - 2. At unformed surfaces, screed concrete to produce a surface that when finished with patching mortar will match required profile and surrounding concrete.
- D. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.
- E. Protect newly applied material from rain, sun, and wind until compressive strength is 70% of the 28 day compressive strength. To prevent from freezing cover with insulating material. Setting time is dependent on temperature and humidity.
- F. Adhere to all procedures, limitations and cautions for the polymer-modified portland cement mortar in the manufacturers current printed Product Data Sheet (PDS) and literature.

- G. Fill placement cavities with dry-pack mortar and repair voids with patching mortar. Finish to match surrounding concrete.

3.7 APPLICATION OF POLYMER-OVERLAY MATERIALS

- A. Apply polymer overlay in accordance with ACI 503.3.
- B. Apply to traffic-bearing surfaces, including parking areas and walks.

3.8 APPLICATION OF POLYMER-SEALER MATERIALS

- A. Apply polymer sealer by brush, roller, or airless spray at manufacturer's recommended application rate.
- B. Apply to traffic-bearing surfaces, including parking areas and walks.

3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Job-Mixed Patching-Mortar Application: 5 randomly selected sets of samples for each type of mortar required, tested for compressive strength in accordance with ASTM C109/C109M.
 - 2. Concrete: As specified in Section 033000 "Cast-in-Place Concrete."
 - 3. Product will be considered defective if it does not pass tests and inspections.
- C. Manufacturers Field Service: Engage manufacturers' factory-authorized service representatives for consultation and Project-site inspection and to provide on-site assistance when requested by Architect.
 - 1. Have manufacturers' factory-authorized service representatives perform the following number of Project-site inspections to observe progress and quality of the Work, distributed over the period of product installation, regardless of on-site assistance requested by Architect:
 - a. Bonding-Agent and Packaged Patching-Mortar Installation Three inspections.
 - b. Joint-Filler Installation: Two
 - c. Polymer-Overlay Installation: Two inspections.
 - d. Polymer Sealer: Two inspections.
 - e. Composite-Structural Reinforcement: Two
- D. Prepare test and inspection reports.

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" 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. Form-facing material for cast-in-place concrete.
 - 2. Shoring, bracing, and anchoring.
- B. Related Requirements:
 - 1. Section 321313 "Concrete Paving" for formwork related to concrete pavement and walks.

1.4 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.

1.5 ACTION SUBMITTALS

- A. Product Data: For each of the following:
 - 1. Form ties.
 - 2. Waterstops.
- B. Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.
 - 1. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301.
 - a. Location of construction joints is subject to approval of the Architect.

2. Indicate location of waterstops.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing and inspection agency.
- B. Field quality-control reports.

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.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. 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.

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 HDO (high-density overlay).

- 2) APA MDO (medium-density overlay); mill-release agent treated and edge sealed.
 - 3) APA Structural 1 Plyform, B-B or better; mill oiled and edge sealed.
 - 4) APA Plyform Class I, B-B or better; mill oiled 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.

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.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
1. Sika USA (Basis of Design)
 2. Minerals Technologies Inc.
 3. Cemflex
 4. Or equal as approved by the Professional

2.4 RELATED MATERIALS

- A. Reglets: Fabricate reglets of not less than 0.022-inch-thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- B. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- C. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- D. 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.
- E. 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.
 2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
 3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

- A. Comply with ACI 301.
- B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 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-1.0: ACI 117 Class D, 1 inch.
 - 2. Surface Finish-2.0: ACI 117 Class B, 1/4 inch.
 - 3. Surface Finish-3.0: ACI 117 Class A, 1/8 inch.
 - 4.
- 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.
- 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. Locate joints for beams, slabs, joists, and girders in the middle third of spans.
 - a. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
5. 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.

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.

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 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. 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. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- C. 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 03 10 00

SECTION 032000
CONCRETE REINFORCING

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 reinforcement bars.
 2. Welded-wire reinforcement.
- B. Related Requirements:
1. Section 321313 "Concrete Paving" for reinforcing related to concrete pavement and walks.

1.3 ACTION SUBMITTALS

- A. Product Data: For the following:
1. Each type of steel reinforcement.
 2. Bar supports.
- B. Shop Drawings: Comply with ACI SP-066:
1. Include placing drawings that detail fabrication, bending, and placement.
 2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.
 3. For structural thermal break insulated connection system, indicate general configuration, insulation dimensions, tension bars, compression pads, shear bars, and dimensions.
- C. Construction Joint Layout: Indicate proposed construction joints required to build the structure.
1. Location of construction joints is subject to approval of Architect.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Statements: For testing and inspection agency.
- B. Material Test Reports: For the following, from a qualified testing agency:

1. 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.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

- 1. Store reinforcement to avoid contact with earth.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.
- B. Steel Bar Mats: ASTM A184/A184M, fabricated from ASTM A615/A615M, Grade 60, deformed bars, assembled with clips.
- C. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.

2.2 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A615/A615M, Grade 60, 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. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch in diameter.

1. Finish: Plain.

2.3 FABRICATING REINFORCEMENT

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

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protection of In-Place Conditions:
 1. Do not cut or puncture vapor retarder.
 2. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 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, 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.
- 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 to be lapped not less than 36 bar diameters at splices, or 24 inches, whichever is greater.
 2. Stagger splices in accordance with ACI 318.
- G. 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 to not exceed 12 inches.
 2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches for plain wire and 8 inches for deformed wire.
 3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.

4. Lace overlaps with wire.

3.3 JOINTS

- A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 1. Place joints perpendicular to main reinforcement.
 2. Continue reinforcement across construction joints unless otherwise indicated.
 3. Do not continue reinforcement through sides of strip placements of floors and slabs.
- B. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length, to prevent concrete bonding to one side of joint.

3.4 INSTALLATION TOLERANCES

- A. Comply with ACI 117.

3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- C. Inspections:
 1. Steel-reinforcement placement.

END OF SECTION 03 20 00

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" 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. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.
- B. Related to Requirements: Each
 - 1. Section 031000 "Concrete Forming and Accessories" for form-facing materials, form liners, insulating concrete forms, and water stops.
 - 2. Section 032000 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.
 - 3. Section 312000 "Earth Moving" for drainage fill under slabs-on-ground.
 - 4. Section 321313 "Concrete Paving" for concrete pavement and walks.

1.4 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.

1.5 ACTION SUBMITTALS

- A. Product Data: For each of the following.
 - 1. Portland cement.
 - 2. Fly ash.
 - 3. Slag cement.
 - 4. Aggregates.
 - 5. Admixtures:

- a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.
 - 6. Vapor retarders.
 - 7. Curing materials.
 - a. Include documentation from color pigment manufacturer, indicating that proposed methods of curing are recommended by color pigment manufacturer.
 - 8. Joint fillers.
 - 9. Repair materials.
- B. Design Mixtures: For each concrete mixture, include the following:
- 1. Mixture identification.
 - 2. Minimum 28-day compressive strength.
 - 3. Durability exposure class.
 - 4. Maximum w/cm.
 - 5. Slump limit.
 - 6. Air content.
 - 7. Nominal maximum aggregate size.
 - 8. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
 - 9. Intended placement method.
 - 10. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- C. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:
- 1. Concrete Class 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. Material Certificates: For each of the following, signed by manufacturers:
- 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Curing compounds.
 - 4. Bonding agents.
 - 5. Adhesives.
 - 6. Vapor retarders.
 - 7. Semirigid joint filler.

8. Joint-filler strips.
9. Repair materials.

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

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Aggregates.
5. Admixtures:

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

E. Field quality-control reports.

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.

1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.

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.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94/C94M and ACI 301.

1.9 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 301 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 for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
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, 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 and ACI 305.1, and as follows:

1. Maintain concrete temperature at time of discharge to not exceed 95 deg F.
2. Fog-spray forms, steel reinforcement, and sub-grade just before placing concrete. Keep sub-grade uniformly moist without standing water, soft spots, or dry areas.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/ termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

2.2 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.
4. Obtain each type of admixture from single source from single manufacturer.

B. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, Type I/II,.

2. Fly Ash: ASTM C618, Class C or F.
 3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
- C. 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. for moderately reactive aggregate or 3 lb./cu. yd. 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.
 2. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
 3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Air-Entraining Admixture: ASTM C260/C260M.
- E. 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 in steel-reinforced concrete.
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.
- F. Water and Water Used to Make Ice: ASTM C94/C94M, potable

2.3 VAPOR RETARDERS

- A. Sheet Vapor Retarder, Class A: ASTM E1745, Class A, except with maximum water-vapor permeance of Insert rating; not less than 15 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive tape.

2.4 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.
 1. Color:

- a. Ambient Temperature Below 50 deg F: Black.
 - b. Ambient Temperature between 50 deg F and 85 deg F: Any color.
 - c. Ambient Temperature Above 85 deg F: White.
- D. Curing Paper: Eight-foot-wide paper, consisting of two layers of fibered kraft paper laminated with double coating of asphalt.
- E. Water: Potable or complying with ASTM C1602/C1602M.
- F. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B.

2.5 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D1752, cork or self-expanding cork.
- B. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
- C. 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.

2.6 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch 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 or coarse sand, as recommended by underlayment manufacturer.
 - 4. Compressive Strength: Not less than 4100 psi 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 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 or coarse sand as recommended by topping manufacturer.
 - 4. Compressive Strength: Not less than [5000 psi] at 28 days when tested in accordance with ASTM C109/C109M.

2.7 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.
 - 1. Use a qualified 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.
 - 5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
- C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

2.8 CONCRETE MIXTURES

- A. Class A: Normal-weight concrete used for footings and foundation walls.
 - 1. Exposure Class: ACI 318 F1 S0 W0 C1.
 - 2. Minimum Compressive Strength: 4000 psi at 28 days.
 - 3. Maximum w/cm: 0.50.
 - 4. Air Content:
 - a. Exposure Class F1: 5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.
 - 5. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- B. Class B: Normal-weight concrete used for interior slabs-on-ground.
 - 1. Exposure Class: ACI 318 F0 S0 W0 C0.
 - 2. Minimum Compressive Strength: 3500 psi at 28 days.
 - 3. Maximum w/cm: 0.50.
 - 4. Minimum Cementitious Materials Content: 540 lb/cu. yd..
 - 5. Air Content:
 - a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.
 - 6. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

2.9 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M, 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. 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., 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, 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.

3.3 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.
 - 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 ANSI/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.

3.4 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 sealing vapor retarder to concrete.
 4. Lap joints 6 inches 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 on all sides, and sealing to vapor retarder.

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. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 4. Space vertical joints in walls as indicated on Drawings. Unless otherwise indicated on Drawings, locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.
 5. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 6. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control 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. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action does

not tear, abrade, or otherwise damage surface and before concrete develops random cracks.

- 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 or more than 1 inch 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.

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. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect in writing, 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. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, 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.
- E. 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.
 - 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 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.
- F. 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 Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.
 - a. Patch voids larger than 1-1/2 inches wide or 1/2 inch deep.
 - b. Remove projections larger than 1 inch.
 - c. Tie holes do not require patching.
 - d. Surface Tolerance: ACI 117 Class D.
 - e. Apply to concrete surfaces not exposed to public view .

B. 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 in one direction.
3. Apply scratch finish to surfaces to receive concrete floor toppings or [o 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 117tolerances for conventional concrete.
3. Apply float finish to surfaces to receive trowel finish.

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 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) Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.-long straightedge resting on two high spots and placed anywhere on the surface does not exceed [3/16 inch] [1/8 inch] [1/8 inch and also no more than1/16 inch in2 feet].

b. Suspended Slabs:

- 1) Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed [3/16 inch] [1/8 inch] [1/8 inch and also no more than1/16 inch in 2 feet

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thin set 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 Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases 6 inches high unless otherwise indicated on Drawings, and extend base not less than 6 inches 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: 4000 psi at 28 days.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch 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.

3.10 CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

1. Comply with ACI 301 and ACI 306.1 for cold weather protection during curing.
2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h before and during finishing operations.

B. Curing Formed Surfaces: Comply with ACI 308.1 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 308.1as 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
 - 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, 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 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.

3.11 TOLERANCES

- A. Conform to ACI 117

3.12 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] [six] month(s).
 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 deep in formed joints.
- D. Overfill joint, and trim joint filler flush with top of joint after hardening.

3.13 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 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 in any dimension to solid concrete.
 - a. Limit cut depth to 3/4 inch
 - 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 inchwide 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 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 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 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 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.

3.14 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.
- B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform tests and 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.
- C. 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.

D. Inspections:

1. Headed bolts.
2. Verification of use of required design mixture.
3. Concrete placement, including conveying and depositing.
4. Curing procedures and maintenance of curing temperature.
5. Verification of concrete strength before removal of shores and forms from beams and slabs.
6. Batch Plant Inspections: On a random basis, as determined by Architect.

E. 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. but less than 25 cu. yd. plus one set for each additional 50 cu. yd. 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, 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.
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;.
 - 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 and below or 80 deg F and above, and one test for each composite sample.
6. Compression Test Specimens: ASTM C31/C31M:
 - a. Cast and laboratory cure two sets of three 6-inch by 12-inch or 4-inch by 8-inch cylinder specimens for each composite sample.
7. Compressive-Strength Tests: ASTM C39/C39M.
 - a. Test one set of three laboratory-cured specimens at seven days and one set of two specimens at 28 days.
 - b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

8. 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.
9. 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 if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi
10. 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.
11. 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 section 1.6.6.3.
12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

- F. Measure floor and slab flatness and levelness in accordance with ASTM E1155 within 24 hours of completion of floor finishing and promptly report test results to Architect.

3.15 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.

END OF SECTION 03 30 00

SECTION 042000

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.
 - 2. Mortar and grout.
 - 3. Steel reinforcing bars.
 - 4. Masonry-joint reinforcement.
 - 5. Ties and anchors.
 - 6. Embedded flashing.
 - 7. Miscellaneous masonry accessories.
- B. Products Installed but not Furnished under This Section:
 - 1. Steel lintels in unit masonry.

1.3 DEFINITIONS

- A. CMU(s): Concrete masonry unit(s).
- B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide structural unit masonry assemblies that develop indicated net-area compressive strengths at 28 days.
 - 1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to TMS 602/ACI 530.1/ASCE 6.
 - 2. Net Area Compressive Strength of Concrete Masonry Assemblies: $f_m = 2,000$ psi.

1.5 PREINSTALLATION MEETINGS

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

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

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For the following:
 - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
 - 2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315. Show elevations of reinforced walls.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Material Certificates: For each type and size of the following:
 - 1. Masonry units.
 - a. Include material test reports substantiating compliance with requirements.
 - 2. Cementitious materials. Include name of manufacturer, brand name, and type.
 - 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.
- C. 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/C 91M for air content.
 - 2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
- D. 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 TMS 602/ACI 530.1/ASCE 6.
- E. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.8 QUALITY ASSURANCE

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

1.9 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. Store preblended, dry mortar mix in delivery containers on elevated platforms 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.

1.10 FIELD 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.
- 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 TMS 602/ACI 530.1/ASCE 6.
 - 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 TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. 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.
- B. 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.

2.2 UNIT MASONRY, GENERAL

- A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6 except as modified by requirements in the Contract Documents.
- B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work and will be within 20 feet vertically and horizontally of a walking surface.

2.3 CONCRETE MASONRY UNITS (CMUs)

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. H & K Group, Inc. (Basis-of-Design)
 - b. Fizzano Brothers Concrete Products
 - c. ACME Block & Brick
- 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. Integral Water Repellent: Provide units made with integral water repellent.
 - 1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested according to ASTM E 514/E 514M as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, shall show no visible water or leaks on the back of test specimen.
- D. Size: Standard units with nominal face dimensions of 16 inches long and 8 inches high (15-5/8 inches by 7-5/8 inches actual), with nominal thicknesses as indicated on drawings for various locations.
- E. CMUs: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2000 psi.
2. Density Classification: Normal weight unless otherwise indicated.

2.4 MASONRY LINTELS:

- A. General: Provide masonry lintels at each opening in masonry walls and partitions.
- B. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.5 MORTAR AND GROUT MATERIALS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Laticrete (Basis-of-Design)
 - b. Holcim US
 - c. NHL Mortar
- B. Portland Cement: ASTM C 150/C 150M, 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.
 1. Alkali content shall not be more than 0.1 percent when tested according to ASTM C 114.
- C. Hydrated Lime: ASTM C 207, Type S.
- D. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- E. Masonry Cement: ASTM C 91/C 91M.
- F. Mortar Cement: ASTM C 1329/C 1329M.
- G. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.
- H. Colored Cement Product: Packaged blend made from portland cement and lime and mortar pigments, all complying with specified requirements, and containing no other ingredients.
 1. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
 2. Pigments shall not exceed 10 percent of portland cement by weight.
 3. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
- I. 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.

J. Aggregate for Grout: ASTM C 404.

K. 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.

L. Water: Potable.

2.6 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars, Galvanized: ASTM A 615 or ASTM A 996, Grade 60.

B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to 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.

C. Masonry-Joint Reinforcement, General: ASTM A 951.

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 diameter.
4. Wire Size for Cross Rods: 0.148-inch diameter.
5. Wire Size for Veneer Ties: 0.187-inch diameter.
6. Spacing of Cross Rods: Not more than 16 inches o.c.
7. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.
8. Provide ladder type reinforcing.

D. Masonry-Joint Reinforcement for Single-Wythe Masonry: Ladder type with single pair of side rods.

2.7 TIES AND ANCHORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

- a. Heckmann Building Products Inc
- b. Hohmann & Barnard,
- c. Masonpro
- d. Or equal as approved by the Professional.

B. General: Ties and anchors shall extend at least 1-1/2 inches into masonry but with at least a 5/8-inch cover on outside face.

C. 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, Class B-2 coating.
 2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
 3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- D. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch-diameter, hot-dip galvanized steel wire.
 2. Tie Section: Triangular-shaped wire tie made from 0.187-inch-diameter, hot-dip galvanized steel.
- E. Partition Top Anchors: 0.105-inch-thick metal plate with a 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.
- F. 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.

2.8 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:
1. Stainless Steel: ASTM A 240/A 240M or ASTM A 666, 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 metal flashing embedded in masonry from stainless steel, with ribs at 3-inch intervals along length of flashing to provide an integral mortar bond.
 4. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
 5. Fabricate through-wall flashing with drip edge. Fabricate by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
 6. Fabricate through-wall flashing with sealant stop where indicated. Fabricate by bending metal back on itself 3/4 inch at exterior face of wall and down into joint 1/4 inch to form a stop for retaining sealant backer rod.
 7. Fabricate metal drip edges and sealant stops for ribbed metal flashing from plain metal flashing of same metal as ribbed flashing and extending at least 3 inches into wall with hemmed inner edge to receive ribbed flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam sheds water.
 8. Fabricate metal expansion-joint strips from stainless steel to shapes indicated.
 9. Solder metal items at corners.
- B. Application: Provide metal flashing at all locations, including:
1. Where flashing is indicated to receive counterflashing.
 2. Where flashing is indicated to be turned down at or beyond the wall face.
 3. Where flashing is partly exposed and is indicated to terminate at the wall face.
 4. Where flashing is fully concealed.

- C. Solder and Sealants for Sheet Metal Flashings:
 - 1. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
- D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.9 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; 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 felt complying with ASTM D 226/D 226M, Type I (No. 15 asphalt felt).
- D. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 0.142-inch steel wire, hot-dip galvanized after fabrication. Provide units with either two loops or four loops as needed for number of bars indicated.
- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817. (Basis-of-Design)
 - 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.
 - e. Or equal as approved by the Professional.

2.10 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.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Diedrich Technologies, Inc.
 - b. EaCo Chem, Inc.
 - c. ProSoCo, Inc.
 - d. Or equal as approved by the Professional.

2.11 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.
- 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 and Property Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
 - 1. Type S Mortar: At concrete masonry units.
- D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
 - 1. Pigments shall not exceed 10 percent of portland cement by weight.
 - 2. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
 - 3. Mix to match existing Powerhouse Building 23 exterior brick mortar.
 - 4. Application: Use pigmented mortar for exposed mortar joints with the following units:
 - a. Clay 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 TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
 - 2. Proportion grout in accordance with ASTM C 476, paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 3000 psi.
 - 3. Provide grout with a slump of 8 to 11 inches 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 the Work.
 - 2. Verify that foundations are within tolerances specified.
 - 3. Verify that reinforcing dowels are properly placed.
 - 4. Verify that substrates are free of substances that would impair mortar bond.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping.

- 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 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. Mix units from several pallets or cubes as they are placed.
- F. Contractor shall 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.

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.

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.

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 4 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 stepping 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 masonry 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 space between steel frames and masonry solidly with mortar unless otherwise indicated.
- G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.
- H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.
- I. Build nonload-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.

3.5 COMPOSITE MASONRY

- A. Bond wythes of composite masonry together as follows:
 - 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.
- B. Collar Joints: Solidly fill collar joints by parging face of first wythe that is laid and shoving units of other wythe into place.

3.6 MORTAR BEDDING AND JOINTING

- A. Lay hollow CMUs as follows:
 - 1. Bed face shells in mortar and make head joints of depth equal to bed joints.
 - 2. Bed webs in mortar in all courses of piers, columns, and pilasters.
 - 3. Bed webs in mortar in grouted masonry, including starting course on footings.
 - 4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
- B. Lay solid CMUs 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.
- E. Cut joints flush where indicated to receive waterproofing unless otherwise indicated.

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. at interior CMU walls.
 - 2. Space reinforcement not more than 8 inches o.c. at exterior CMU walls, CMU back-up walls at cavity wall construction, foundation walls, and parapet walls.
 - 3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.
- 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.

- E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, pipe enclosures, and other special conditions.

3.8 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

- A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:
 - 1. Provide an open space not less than 1/2 inch wide between masonry and structural steel or 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 16 inches o.c. vertically and 24 inches o.c. horizontally

3.9 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.
- 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.

3.10 LINTELS

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

3.11 FLASHING, WEEP HOLES, AND CAVITY 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. Install cavity vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, 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 4 inches, and 1-1/2 inches into the inner wythe.
 3. 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.
 4. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
 5. Install metal drip edges and sealant stops with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
- C. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.
- D. Install weep holes in exterior wythes and veneers in head joints of first course of masonry immediately above embedded flashing.
1. Use specified weep/cavity vent products to form weep holes.
 2. Use wicking material to form weep holes above flashing under sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
 3. Space weep holes 24 inches o.c. unless otherwise indicated.
 4. Space weep holes formed from plastic tubing 16 inches o.c.
 5. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
 6. Trim wicking material flush with outside face of wall after mortar has set.
- E. Place cavity drainage material in cavities and airspace behind veneers to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.
- F. Install cavity vents in head joints in exterior wythes at spacing indicated. Use[specified weep/cavity vent products to form cavity vents.
1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.12 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 TMS 602/ACI 530.1/ASCE 6.
 - 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 TMS 602/ACI 530.1/ASCE 6 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.

3.13 FIELD QUALITY CONTROL

- A. See Section 014000 "Quality Control Testing Services" for testing and inspecting provided by the Contractor.
- B. See Section 014010 "Quality Assurance Testing and Inspection Services" for testing and inspecting provided by the Quality Assurance Agency.
 1. The Professional shall retain the services of an independent quality assurance agent certified to perform the following special inspections required by the 2018 International Building Code. 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.

3.14 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. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Professional's approval of sample cleaning before proceeding with cleaning of masonry.
 3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.

5. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

3.15 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. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.
- D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Client Agency's property.

END OF SECTION 042000

SECTION 051200
STRUCTURAL STEEL FRAMING

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. Structural steel.
 - 2. Shrinkage-resistant grout.
- B. Related Requirements:
 - 1. Section 055000 "Metal Fabrications" for miscellaneous steel fabrications and other steel items not defined as structural steel.

1.3 DEFINITIONS

- A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.

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 ACTION SUBMITTALS

- A. Product Data:
 - 1. Structural-steel materials.
 - 2. High-strength, bolt-nut-washer assemblies.
 - 3. Anchor rods.
 - 4. Shrinkage-resistant grout.
- B. Shop Drawings: Show fabrication of structural-steel components.
 - 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.
- C. Delegated Design Submittal: For structural-steel connections indicated on Drawings to comply with design loads, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 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 or is accredited by the IAS Fabricator Inspection Program for Structural Steel (Acceptance Criteria 172).
- B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector.
- C. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.
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.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. 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.
- B. 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 F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with applicable provisions of the following specifications and documents:

1. ANSI/AISC 303.
- B. Connection Design Information:
 1. Design connections and final configuration of member reinforcement at connections in accordance with ANSI/AISC 303 by fabricator's qualified professional engineer.
 - a. Use loads indicated on drawings.
- C. Moment Connections: As indicated on the drawings.
- D. Construction: Shear Wall System

2.2 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A992/A992M.
- B. Channels, Angles: ASTM A36/A36M.
- C. Plate and Bar: ASTM A36/A36M.
- D. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade B structural tubing.
- E. Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.
- F. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

- A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
- B. High-Strength A490 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A490, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.

2.4 RODS

- A. Headed Anchor Rods: ASTM F1554, Grade 36, straight.
 1. Nuts: ASTM A563 heavy-hex carbon steel.
 2. Plate Washers: ASTM A36/A36M carbon steel.
 3. Washers: ASTM F436, Type 1, hardened carbon steel.
 4. Finish: Plain.
- B. Threaded Rods: ASTM A36/A36M.
 1. Nuts: ASTM A563 heavy-hex carbon steel.
 2. Washers: ASTM F436, Type 1, hardened carbon steel.
 3. Finish: Plain.

2.5 PRIMER

A. Steel Primer:

1. Comply with Section 099120 "Interior and Exterior Painting,"

2.6 SHRINKAGE-RESISTANT GROUT

- A. Metallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.
- B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.7 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.
1. Fabricate beams with rolling camber up.
 2. Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing has been erected.
 3. Mark and match-mark materials for field assembly.
 4. 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, 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 in accordance with SSPC-SP 2.
- F. 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.

2.8 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength 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 ANSI/AISC 303 for mill material.

2.9 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123/A123M.
 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 as well as all structural steel indicated on the drawings exposed to the environment.
- B. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter, and treating with etching cleaner or in accordance with SSPC-SP 16.

2.10 SOURCE QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform shop tests and inspections.
 1. Allow testing agency access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
 2. Bolted Connections: Inspect and test shop-bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
 3. Welded Connections: Visually inspect shop-welded connections in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E165/E165M.
 - b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
 - c. Ultrasonic Inspection: ASTM E164.
 - d. Radiographic Inspection: ASTM E94/E94M.
 4. In addition to visual inspection, test and inspect shop-welded shear stud connectors in accordance with requirements in AWS D1.1/D1.1M for stud welding and as follows:
 - a. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear stud connector.
 - b. Conduct tests in accordance with requirements in AWS D1.1/D1.1M on additional shear stud connectors if weld fracture occurs on shear stud connectors already tested.
 5. 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 on Drawings.
 - 1. Do not remove temporary shoring supporting composite deck construction and structural-steel framing 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 in accordance with ANSI/AISC 303 and ANSI/AISC 360.
- B. Baseplates 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 shrinkage-resistant 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 grouting.
- C. Maintain erection tolerances of structural steel within ANSI/AISC 303.
- 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. Slope roof framing members to slopes indicated on Drawings.
 - 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.

3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type 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 ANSI/AISC 303 and ANSI/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 where indicated, back gouge, and grind steel smooth.
 - 3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

3.5 REPAIR

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing, and repair galvanizing to comply with ASTM A780/A780M.

3.6 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform the following special inspections:
 - 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.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
 - 1. Bolted Connections: Inspect and test bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
 - 2. Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M.
 - a. In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - 1) Liquid Penetrant Inspection: ASTM E165/E165M.
 - 2) Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.

- 3) Ultrasonic Inspection: ASTM E164.
- 4) Radiographic Inspection: ASTM E94/E94M.

END OF SECTION 05 12 00

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" 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 deck.
- B. Related Requirements:
 - 1. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. Roof deck.
- 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 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Welding Qualifications: Qualify procedures and personnel in accordance with SDI QA/QC and the following welding codes:
 - a. AWS D1.1/D1.1M.
 - b. AWS D1.3/D1.3M.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Store products in accordance with SDI MOC3. 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 in accordance with AISI S100.
- B. Fire-Resistance Ratings: Comply with ASTM E119; 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 listings of another qualified testing agency.

2.2 ROOF DECK

- A. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with SDI RD and with the following:
 - 1. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 33, G60 zinc coating.
 - 2. Deck Profile: As indicated
 - 3. Profile Depth: As indicated.
 - 4. Design Uncoated-Steel Thickness: As indicated
 - 5. Span Condition: As indicated.
 - 6. Side Laps: Overlapped.

2.3 ACCESSORIES

- A. 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 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 not less than 0.0359-inch 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), of same material and finish as deck, and of thickness and profile recommended by SDI standards 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. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.
- J. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck, with 3-inch- wide flanges and [level] [sloped] recessed pans of 1-1/2-inch minimum depth. For drains, cut holes in the field.
- K. Galvanizing Repair Paint: ASTM A780/A780M.

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 in accordance with SDI C, SDI NC, and SDI RD, as applicable; 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 in accordance with deck manufacturer's written instructions.

3.3 INSTALLATION OF ROOF DECK

- A. Fasten roof-deck panels to steel supporting members as indicated on the design documents

- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals as indicated on the design documents.
- 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: Lapped 2 inches minimum
- D. 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 apart with at least one fastener at each corner.
 - 1. Install reinforcing channels or zees in ribs to span between supports as required.
- E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels in accordance with deck manufacturer's written instructions. Weld or 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.
- F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive in accordance with manufacturer's written instructions to ensure complete closure.

3.4 REPAIR

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint in accordance with ASTM A780/A780M and manufacturer's written instructions.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Special inspections and qualification of welding special inspectors for cold-formed steel floor and roof deck in accordance with quality-assurance inspection requirements of SDI QA/QC.
 - a. Field welds will be subject to inspection.
 - 2. Steel decking will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 05 31 00

SECTION 054000
COLD-FORMED 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 RELATED DOCUMENTS

- 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.

1.3 SUMMARY

- A. Section Includes:
 - 1. Exterior non-load-bearing wall framing.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference for Exterior Framing: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of cold-formed steel framing product and accessory.
- B. Shop Drawings:
 - 1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners and welds.
 - 2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, accessories, connection details, and attachment to adjoining work.
- C. Delegated-Design Submittal: For cold-formed steel framing.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Welding certificates.

- C. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency.
 - 1. Power-actuated anchors.
 - 2. Mechanical fasteners.
 - 3. Vertical deflection clips.
 - 4. Miscellaneous structural clips and accessories.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code - Steel."
 - 2. AWS D1.3, "Structural Welding Code - Sheet Steel."

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with project requirements, manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Clark Dietrich Building Systems (Basis of Design)
 - 2. MarinoWARE.
 - 3. Telling Industries.
 - 4. Or equal as approved by the Professional.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer registered in the Commonwealth of Pennsylvania to design cold-formed steel framing. Submit calculations for review which include:
 - 1. Design Criteria.
 - 2. Structural Analysis for each unique framing application.
 - 3. Selection of framing components and accessories and verification of connections.
- B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.
 - 1. Design Loads: In accordance with IBC 2015.
 - 2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
 - a. Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/600 of the wall height.

3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 150 deg F.
 4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
 - a. Upward and downward movement of 3/4 inch.
 5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.
- C. Cold-Formed Steel Framing Design Standards:
1. Wall Studs: AISI S211.
 2. Headers: AISI S212.
 3. Lateral Design: AISI S213.
- D. AISI Specifications and Standards: Unless more stringent requirements are indicated, comply with AISI S100 and AISI S200.

2.3 COLD-FORMED STEEL FRAMING, GENERAL

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Minimum Steel Thickness (all locations): 14 gauge.
- C. Steel Sheet: ASTM A 1003, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:
1. Grade: As required by structural performance. Minimum yield strength of 33 ksi.
 2. Coating:
 - a. Exterior Locations: G90.
- D. Steel Sheet for Clips: ASTM A 653, structural steel, zinc coated.
1. Grade and coating to match framing members.
- E. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
1. Minimum Flange Width:
 - a. Exterior Locations: 2 inches.
- F. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
1. Flange Width: 1-1/4 inches.
- G. Vertical Deflection Clips: Manufacturer's standard clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

- H. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.
 - 1. Outer Track: Of web depth to allow free vertical movement of inner track, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
 - a. Flange Width: 1 inch plus twice the design gap.
 - 2. Inner Track: Of web depth indicated, and as follows:
 - a. Flange Width: Dimension equal to sum of outer deflection track flange width plus 1 inch.
- I. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.4 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.
- B. Provide accessories of manufacturer's standard configuration and thickness to match framing members, unless otherwise indicated, as follows:
 - 1. Supplementary framing.
 - 2. Bracing, bridging, and solid blocking.
 - 3. Web stiffeners.
 - 4. Anchor clips.
 - 5. End clips.
 - 6. Gusset plates.
 - 7. Stud kickers and knee braces.
 - 8. Hole reinforcing plates.
 - 9. Backer plates.

2.5 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A 36, zinc coated by hot-dip process according to ASTM A 123.
- B. Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel headless bolts, with encased end threaded, and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153, Class C.
- C. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.
- D. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, minimum #12-14 self-drilling, self-tapping, steel drill screws.
 - 1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.
- E. Welding Electrodes: Comply with AWS standards.

2.6 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: SSPC-Paint 20 or MIL-P-21035B.
- B. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C 1107/C 1107M, with fluid consistency and 30-minute working time.
- C. Shims: Load bearing, high-density multimonomer plastic, and nonleaching; or of cold-formed steel of same grade and coating as framing members supported by shims.
- D. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

2.7 FABRICATION

- A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
 - 1. Fabricate framing assemblies using jigs or templates.
 - 2. Cut framing members by sawing or shearing; do not torch cut.
 - 3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by no fewer than three exposed screw threads.
 - 4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.
 - 5. Splicing of members is not permitted.
- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.
- C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
 - 1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
 - 2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting substrates 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 PREPARATION

- A. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to AISI S200 and to manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
 - 1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.
- D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
 - 1. Cut framing members by sawing or shearing; do not torch cut.
 - 2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.
- E. Install framing members in one-piece lengths.
- F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.
- H. Install insulation, specified in Section 072100 "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.
- J. Erection Tolerances: Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
2. Maximum framing member spacing: 16 inches.

3.4 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.
- B. Fasten both flanges of studs to top and bottom track unless otherwise indicated.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
 1. Install double deep-leg deflection tracks and anchor outer track to building structure.
 2. Connect vertical deflection clips to studs and anchor to building structure.
 3. Connect drift clips to cold-formed metal framing and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection. Provide one of the following:
 1. Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
 2. Proprietary bridging bars installed according to manufacturer's written instructions.
- F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 FIELD QUALITY CONTROL

- A. Testing: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field and shop welds will be subject to testing and inspecting.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Remove and replace work where test results indicate that it does not comply with specified requirements.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.6 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000

SECTION 055000
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. Miscellaneous steel framing and supports, including clip angles.
 2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
 3. Miscellaneous steel trim.
 4. Loose bearing plates and leveling plates for applications where they are not specified in other sections.
 5. Ladders.
- B. Products furnished, but not installed, under this section include the following:
1. Loose steel lintels.
 2. Anchor bolts, steel pipe sleeves and wedge type inserts indicated to be cast into concrete or built into unit masonry.
 3. Steel weld plates and angles for casing into concrete for applications where they are not specified in other sections.

1.3 ACTION SUBMITTALS

- A. Shop Drawings: Show fabrication and installation details for metal fabrications.
1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

PART 2 - PRODUCTS

2.1 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces without blemishes.

2.2 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36.
- B. Steel Pipe: ASTM A 53, standard weight (Schedule 40) unless otherwise indicated.

2.3 FASTENERS

- A. 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.
 - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594
- B. Steel Ladders:
- C. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Cotterman. (Basis-of-Design)
 - b. F.S. Industries
 - c. National Ladder & Scaffold Company
 - d. Or equal as approved by the Professional.
- 2. Space siderails 18 inches (457 mm) apart unless otherwise indicated.
- 3. Siderails: Continuous, 3/8-by-2-1/2-inch (9.5-by-64-mm) steel flat bars, with eased edges.
- 4. Rungs: 3/4-inch- (19-mm-) diameter
- 5. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
- 6. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
- 7. Nonslip Surfaces for Steel Ladders: Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.
- 8. Source Limitations: Obtain nonslip surfaces from single source from single manufacturer.
- 9. Support each ladder at top and bottom and not more than 60 inches (1500 mm) o.c. with welded or bolted steel brackets.
- 10. Prime exterior ladders, including brackets and fasteners, with zinc-rich primer.

2.4 MISCELLANEOUS MATERIALS

- A. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
- B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.5 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Use connections that maintain structural value of joined pieces.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.
- C. 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.
- D. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Locate joints where least conspicuous.

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.

2.7 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.
- C. Steel plate jambs at overhead doors:
 - 1. Fully welded and ground smooth.
 - 2. Minimum 3/8 inch thick.
 - 3. Galvanize and prime.

2.8 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. Prime plates with zinc-rich primer.

2.9 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 and prime loose steel lintels located in exterior walls.

2.10 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.

2.11 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.

2.12 STEEL AND IRON FINISHES

- A. Shop prime iron and steel items unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
 - 1. Shop prime with universal shop primer.
- B. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 3, "Power Tool Cleaning".
- C. 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.

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.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction.

3.2 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.

3.3 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055000

SECTION 055200 –
ROOF GUARDRAIL 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 SECTION INCLUDES

- A. Non-penetrating railing system for roof edge fall protection.

1.3 REFERENCES

- A. Occupational Safety and Health Administration (OSHA).

1.4 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- B. Shop Drawings: Drawings showing plans, elevations, sections and details of components.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the job site in good condition and adequately protected against damage as handrails are a finished product.
- B. Inspect rail sections for damage before signing the receipt from the trucking company. Truck driver must note damaged goods on the bill of lading if damaged product is found.
- C. Store products in manufacturer's unopened packaging until ready for installation.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Where handrails and railings are indicated to fit to other construction, check actual dimensions of other construction by accurate field measurements before fabrication.

1.7 WARRANTY

- A. Warranty: Provide manufacture's two (2) year warranty.

PART 2 – PRODUCTS

2.1 MODULAR ALUMINUM RAILINGS FOR ROOF EDGE FALL PROTECTION FOR MEMBRANE ROOFING

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following
1. Kattsafe (Basis of Design)
 2. CAI Safety System
 3. Fall Protection USA
 4. Or equal as approved by the Professional
- B. Basis of Design: Kattsafe GR34 Series by Kattsafe. Modular, free-standing, non-penetrating roof edge protection aluminum guardrail system for built-up and membrane roof applications utilizing top-railing, mid-railing, posts, weighted bases, splice joints, bracing and hardware.
1. Standards compliance:
 - a. ANSI A21.1: Railings and Toe Boards.
 - b. Top and mid rail: OSHA standards - 29 CFR 1910.23 (a)(2).
 - c. Structural Load: OSHA Regulation 29 CFR 1926.502. 200 lbs. (90.7 kg), minimum, in any direction to all components.
 2. Height: 42 inches (1067 mm), minimum.
 3. Railings: Distance between top rail and mid rail cannot exceed 19 inches (483 mm). Distance between mid rail and walking surface cannot exceed 19 inches (483 mm).
 - a. Top rail: 2 inch (51 mm) O.D. high tensile aluminum tubing, mill finish, free of sharp edges and snag points.
 - b. Mid rail: 1-5/8 inch (41 mm) O.D. high tensile aluminum, mill finish tubing, free of sharp edges and snag points. Distance between top rail/mid rail and mid rail/walking surface cannot exceed 19 inches
 4. Mounting posts: 2-1/4 x 1-1/2 x 1/8 inch thick (57 x 38 x 3 mm thick). high tensile aluminum rectangular hollow section, mill finish, free of sharp edges and snag points.
 5. Weighted Bases (H x W x L): 5/8 x 23 x 23 inches (16 x 584 x 584 mm) hot rolled galvanized steel. .
 - a. Pre-tapped holes for post mounting.
 - b. Membrane protection under base.
 6. Splice Joints: Connecting the top and mid rails together in a continuous railing system free of sharp edges and snag points.
 7. Adjustable Elbows: Accommodating angles and elevation changes.
 8. Connecting Hardware: ASTM F593-13a and ASTM F606/F606M-14a. 304 stainless steel. Includes fasteners, rivets (where required) and anchors.
 9. Accessories:
 - a. Toe boards

2.2 ACCESSORIES

- A. Safety/Caution Signage: Cushioned foam strip with self adhesive backing; UL- rated for indoor/outdoor use.
 - 1. Product: Safety Strip.
 - 2. Thickness: 3/8 inch.
 - 3. Length: 36 inches.
 - 4. Width: 4 inches.
 - 5. Color: Safety yellow with black stripes.
- B. Roof Pads: Provide the following pad under base to protect roof membrane.
 - 1. Approved Product: EPDM Roof Pad.
- C. Base Mover: Provide two-wheeled steel cart to transport one base unit.
 - 1. Approved Product: EZ Mover.

2.3 FINISHES

- A. Color: Grey
 - 1. Bases: black.
 - 2. Rails: As selected by Architect from Manufacturer's full range.

2.4 FABRICATION

- A. Assemble components with joints tightly fitted and secured. Accurately form components to suit installation.

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. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.4 PROTECTION

- A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 055200

SECTION 061053

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. Wood blocking, and nailers.
 - 2. Plywood backing panels.
 - 3. Nail base panels with integral rigid insulation.

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.

1.4 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For the following, from ICC-ES:
 - 1. Preservative-treated wood.

1.5 QUALITY ASSURANCE

- A. All companies (manufacturers, distributors, and offsite fabricators) along the supply chain that take legal ownership of FSC-certified forest products and wish to claim their product is FSC-certified must have a FSC Chain of Custody Certificate.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Certified Wood: Lumber and plywood shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

- B. Regional Material for Wood Products: Provide documentation indicating distance to project site, cost for each regional material and fraction by weight that is considered regional.
- C. Wood Products: Provide purchase order indicating FSC certificate number of vendor, line itemized list of contributing material with Chain-of-Custody number and material cost.
- D. 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. Provide dressed lumber, S4S, unless otherwise indicated.
- E. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWP A U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground that are part of roofing assemblies.
 - 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 the following:
 - 1. Wood sills, sleepers, blocking, stripping, and similar concealed members in contact with masonry or concrete exterior envelope components.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. 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. 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.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.
- C. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
- D. Application: Treat the following:

1. Concealed blocking within building envelope.
2. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 1. Rooftop equipment bases and support curbs.
 2. Blocking.
 3. Nailers.
- B. For items of dimension lumber size, provide Construction or No. 2 grade lumber of any species.
- C. For concealed boards, provide lumber with 15 percent maximum moisture content and any of the following species and grades:
 1. Northern species, No. 2 Common grade; NLGA.

2.5 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.
 1. Plywood 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 FASTENERS

- A. General: Provide fasteners of size and type indicated 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, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Screws for Fastening to Metal Framing: ASTM C 954, length as recommended by screw manufacturer for material being fastened.
- F. Bolts: Steel Bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and where indicated, flat washers.
- G. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
 1. VOC Emissions for Wet-Applied Adhesives: Provide certificate of compliance with California Department of Public Health (CDPH) Standard Method v1.1-2010, using the applicable exposure scenario.

2. VOC Content for Wet-Applied Adhesives: Provide documentation of compliant VOC content per SCAQMD Rule 1168

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit.
- B. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- C. Install plywood backing panels by fastening to masonry; 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. Comply with AWPAC M4 for applying field treatment to cut surfaces of preservative-treated lumber.
- F. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.

END OF SECTION 061053

SECTION 061600

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 (Types 1 and 2).

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.
 - 2. Include data for Glass Mat Gypsum Sheathing

1.4 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For following products, from ICC-ES:
 - 1. Glass Mat Gypsum Sheathing

1.5 QUALITY ASSURANCE

- A. All companies (manufacturers, distributors, and offsite fabricators) along the supply chain that take legal ownership of FSC-certified forest products and wish to claim their product is FSC-certified must have a FSC Chain of Custody Certificate.

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 FIRE-RETARDANT-TREATED PLYWOOD

- A. General: 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. 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.
- C. Kiln-dry material after treatment to a maximum moisture content of 15 percent.
- D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.
- E. Application: Treat all plywood.

2.2 WALL SHEATHING

- A. Plywood Wall Sheathing (Type 2): Exterior, Structural I sheathing.
 - 1. Thickness: $\frac{3}{4}$ inch.
- B. Glass-Mat Gypsum Sheathing (Type 1): ASTM C 1177.
 - 1. Manufacturers: Subject to compliance with project requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - a. Georgia-Pacific Gypsum LLC.
 - 1) Product: DensGlass Sheathing (basis of design).
 - b. National Gypsum Company.
 - c. USG Corporation.
 - d. Or equal as approved by the Professional.
 - 2. Type and Thickness: Type X, 5/8 inch thick.
 - 3. Size: 48 by 120 inches for vertical installation.

2.3 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. Provide fasteners of Type 304 stainless steel.
- B. Screws for Fastening 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 from 0.033 to 0.112 inch thick, use screws that comply with ASTM C 954.

2.4 MISCELLANEOUS MATERIALS

- A. Adhesives for Field Gluing Panels to Framing: Formulation complying with ASTM D 3498 that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.
 1. VOC Emissions for Wet-Applied Adhesives: Provide certificate of compliance with California Department of Public Health (CDPH) Standard Method v1.1-2010, using the applicable exposure scenario.
 2. VOC Content for Wet-Applied Adhesives: Provide documentation of compliant VOC content per SCAQMD Rule 1168.

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. NES NER-272 for power-driven fasteners.
 2. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."
 3. Adhere wall sheathing panels to framing, to supplement mechanical fasteners.
- D. Coordinate wall sheathing installation with roofing, 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 GYPSUM SHEATHING INSTALLATION

- A. Comply with GA-253 and with manufacturer's written instructions.
 1. Fasten gypsum sheathing to cold-formed metal framing with screws.
 2. Install panels with a 3/8-inch gap where non-load-bearing construction abuts structural elements.

3. Install panels with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.
- B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.
- C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent panels without forcing. Abut ends over centers of studs, and stagger end joints of adjacent panels not less than one stud spacing. 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.
 2. For sheathing under stucco cladding, panels may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.
- D. 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.

END OF SECTION 061600

SECTION 064020

INTERIOR ARCHITECTURAL WOODWORK

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 1 Specification Sections, apply to this Section.

1.3 SUMMARY

- A. This Section includes the following:
 - 1. Solid-surfacing material countertops with lavatories.
 - 2. Solid-surfacing material sills at existing windows.
 - 3. Solid-surfacing material at Break Room Cabinetry
 - 4. Plastic-laminate material at Break Room
 - 5. Hardware for interior architectural woodwork.

1.4 DEFINITIONS

- A. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items unless concealed within other construction before woodwork installation.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated, including cabinet hardware and accessories, and finishing materials and processes.
 - 1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- 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, faucets and other items installed in architectural woodwork.
 - 2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.

- C. Samples:
 - 1. Solid-surfacing materials.
 - 2. Plastic laminate materials.
- D. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.
- E. Qualification Data: For Installer and fabricator.

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. Shop is a certified participant in AWI's Quality Certification Program.
- B. Installer Qualifications: Certified participant in AWI's Quality Certification Program.
- C. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production of interior architectural woodwork.
- D. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.
- E. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.

1.7 DELIVERY, STORAGE, AND HANDLING

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

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install woodwork 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 woodwork is 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 woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.

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 interior architectural woodwork can be supported and installed as indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide materials that comply with requirements of AWI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
- B. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering high-pressure decorative laminates that may be incorporated into the Work include the following:
 - a. Wilsonart International; Div. of Premark International, Inc (Basis of Design)
 - b. Formica Corporation.
 - c. Nevamar Company, LLC; Decorative Products Div.
 - d. Or equal as approved by the Professional.
 - 2. Colors: As selected by Architect from manufacturer's full range.
 - a. Color L1: Panels below toilet room countertops. TBD
 - b. Color L2: Millwork at Break Room-Blond Echo
- C. Solid-Surfacing Materials: Homogeneous solid sheets of filled plastic resin complying with ISSFA-2.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Wilsonart. (Basis of Design_
 - b. Meganite Inc.; a division of the Pyrochem Group.
 - c. Formica
 - d. Or equal as approved by the Professional.
 - 2. Style:
 - a. Top with integral backsplash and front panel as indicated on Drawings.
 - 1) Provide integral lavatory bowl where indicated. Bowl depth shall comply with accessibility requirements.
 - 2) Countertop depth varies as indicated on drawings.
 - 3) Front panel depth varies as indicated on drawings.
 - 4) Backsplash: 4 inches tall.
 - 3. Colors:
 - a. Color S1: Toilet Room countertop assemblies. Frosty White Mirage
 - b. Color S2: Lavatory bowls within toilet room countertops. White
 - c. Color S3: Breakroom countertop assembly. Frosty White Mirage

2.2 FIRE-RETARDANT-TREATED MATERIALS

- A. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Comply with performance requirements of AWPA C20 (lumber) and AWPA C27 (plywood). Use Exterior Type or Interior Type A. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Kiln-dry material after treatment.

2.3 COUNTERTOP ACCESSORIES

- A. Manufacturer: Subject to compliance with project requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Rakks Corporation. (Basis of Design)
 - 2. DK Hardware
 - 3. Federal Brace
 - 4. Or equal as approved by the Professional:
- B. Material: Aluminum.
- C. Countertop Support Brackets (at Lavatories):
 - 1. Product: Rakks EHV-Vanity Supports.
 - 2. Weight capacity: 450 pounds per bracket.
 - 3. Finish: Mill.
 - 4. Provide treated wood blocking strips for mounting decorative plastic laminate panels to brackets.
 - 5. Size: As indicated on drawings.
 - 6. Spacing: 30 inches, maximum. Provide (3) brackets at lavatory countertop.
- D. Countertop Support Brackets (at Shelf):
 - 1. Product: Rakks EH-Counter Support Bracket.
 - a. EH-1209.
 - b. Cut top leg of bracket to match countertop depth. Smooth cut edges prior to installing support bracket.
 - 2. Weight capacity: 650 pounds per bracket.
 - 3. Finish: Clear Anodized.
 - 4. Spacing: 24 inches, maximum.

2.4 MISCELLANEOUS MATERIALS

- A. Adhesives, General: Do not use adhesives that contain urea formaldehyde.
- B. Installation Adhesive: Product recommended by fabricator for each substrate for secure anchorage.
 - 1. VOC Emissions for Adhesives: Provide certificate of compliance with California Department of Public Health (CDPH) Standard Method v1.1-2010, using the applicable exposure scenario.
 - 2. VOC Content for Adhesives: Provide documentation of compliant VOC content per SCAQMD Rule 1168.
- C. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.

- D. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

2.5 FABRICATION

- A. General: Complete fabrication to maximum extent possible before shipment to Project site. Where necessary for fitting at site, provide allowance for scribing, trimming, and fitting.
1. Interior Woodwork Grade: Premium.
 2. Shop cut openings to maximum extent possible. Sand edges of cutouts to remove splinters and burrs. Seal edges of openings in countertops with a coat of varnish.
 3. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.
 4. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
 5. 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.
 - a. 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 indicated on Shop Drawings before disassembling for shipment.
 6. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, 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.
- B. Plastic Laminate Panels at Countertops: Provide angled panel to cover front of countertop support bracket as indicated on drawings. Bottom of pipe enclosure to remain open, without a panel.
- C. Solid-Surfacing-Material Countertops and Sills:
1. Solid-Surfacing-Material Thickness: As indicated on Drawings.
 2. Fabricate components by mold to achieve shape and configuration.
 3. Radius corners and edges.
 4. Cure components prior to shipment.
 5. Fabricate tops in one piece with field applied side splashes and shop-applied backsplashes where splashes are indicated. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.
 6. Drill holes in countertops for plumbing fittings in shop.
 7. Design Load: 200 lb/sq ft with deflection limited to 1/360.
 8. Design items with sufficient strength for handling and placement stresses.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.
- B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.2 INSTALLATION, GENERAL

- A. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, or too small to fabricate with proper jointing arrangements.
 - 1. Do not use manufactured units with defective surfaces, sizes, or patterns.
- B. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.
 - 1. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
 - 2. Countersink fasteners, fill surface flush, and sand where face fastening is unavoidable.
 - 3. Install to tolerance of 1/8 inch in 96 inches for level and plumb. Install adjoining interior finish carpentry with 1/32-inch maximum offset for flush installation and 1/16-inch maximum offset for reveal installation.
 - 4. Coordinate interior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate interior finish carpentry.

3.3 INSTALLATION

- A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.
- B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.
- C. Install woodwork level, plumb, true, and straight to a tolerance of 1/8 inch in 96 inches. Shim as required with concealed shims.
- D. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.
- E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.
- F. Countertops and Sills: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop. Caulk space between backsplash and wall with sealant specified in Division 7 Section "Joint Sealants."
 - 1. Align adjacent solid-surfacing-material countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface

2. Install countertops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
 3. Secure backsplashes to tops with concealed metal brackets at 16 inches o.c.
 4. Verify vanity supports and affected dimensions are acceptable.
 5. Verify plumbing connections are properly located.
 6. Install components in accordance with shop drawings and manufacturer's instructions.
 7. Align work plumb and level.
 8. Rigidly anchor to substrate to prevent misalignment.
 9. Maximum Variation From True Dimension: 1/8 inch.
 10. Maximum Offset From True Position: 1/8 inch.
 11. Clean and polish fabrication surfaces in accordance with manufacturer's instructions.
- G. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

3.4 ADJUSTING AND CLEANING

- A. Repair damaged and defective woodwork, 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 woodwork on exposed and semi-exposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 064020

SECTION 066400

PLASTIC PANELING

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 sheet paneling.
 - 2. Factory-laminated plastic sheet paneling.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For plastic paneling and trim accessories, in manufacturer's standard sizes.

1.4 QUALITY ASSURANCE

- A. Testing Agency: Acceptable to authorities having jurisdiction

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install plastic paneling until spaces are enclosed and weathertight and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain plastic paneling and trim accessories from single manufacturer.

2.2 PLASTIC SHEET PANELING

- A. Glass-Fiber-Reinforced Plastic Paneling: Gelcoat-finished, glass-fiber-reinforced plastic panels complying with ASTM D5319.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - a. Nudo
 - b. Interstate Plastics
 - c. Marlite
 - d. Or equal as approved by the Professional.
 2. Surface-Burning Characteristics: As follows when tested by a qualified testing agency in accordance with ASTM E84. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.
 3. Nominal Thickness: Not less than 0.09 inch (2.3 mm)
 4. Surface Finish: Smooth
 5. Color: As selected by Architect from manufacturer's full range

2.3 FACTORY-LAMINATED PLASTIC SHEET PANELING

- A. Factory-Laminated PVC Paneling: Solid polyvinyl chloride sheet, laminated to high-impact gypsum board
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - a. Duraclad
 - b. Truscore
 - c. Duramax
 - d. Or equal as approved by the Professional.
 2. Surface-Burning Characteristics: As follows when tested by a qualified testing agency in accordance with ASTM E84. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.
 3. Nominal Thickness: Not less than 0.015 inch (0.38 mm).
 4. Surface Finish: Smooth
 5. Color: Smooth Bright White

2.4 ACCESSORIES

- A. Trim Accessories: Manufacturer's standard two-piece, snap-on vinyl extrusions designed to retain and cover edges of panels. Provide division bars, inside corners, outside corners and caps as needed to conceal edges.

1. Color: As selected by Architect from manufacturer's full range
- B. Exposed Fasteners: Nylon drive rivets recommended by panel manufacturer.
- C. Concealed Mounting Splines: Continuous, H-shaped aluminum extrusions designed to fit into grooves routed in edges of factory-laminated panels and to be fastened to substrate.
- D. Adhesive: As recommended by plastic paneling manufacturer.
- E. Sealant: Mildew-resistant, single-component, neutral-curing silicone sealant recommended by plastic paneling manufacturer and complying with requirements in Section 079200 "Joint Sealants."

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

3.2 PREPARATION

- A. Clean substrates of substances that could impair adhesive bond, including oil, grease, dirt, and dust.
- B. Condition panels by unpacking and placing in installation space before installation according to manufacturer's written recommendations.
- C. Lay out paneling before installing. Locate panel joints where indicated
 1. Mark plumb lines on substrate at trim accessory panel joint locations for accurate installation.
 2. Locate trim accessories panel joints to allow clearance at panel edges according to manufacturer's written instructions.

3.3 INSTALLATION

- A. Install plastic paneling according to manufacturer's written instructions.
- B. Install panels in a full spread of adhesive.
- C. Install panels with fasteners. Layout fastener locations and mark on face of panels so that fasteners are accurately aligned.
 1. Drill oversized fastener holes in panels and center fasteners in holes.
 2. Apply sealant to fastener holes before installing fasteners.
- D. Install factory-laminated panels using concealed mounting splines in panel joints.

- E. Fill grooves in trim accessories with sealant before installing panels, and bed inside corner trim in a bead of sealant.
- F. Maintain uniform space between panels and wall fixtures. Fill space with sealant.
- G. Remove excess sealant and smears as paneling is installed. Clean with solvent recommended by sealant manufacturer and then wipe with clean dry cloths until no residue remains.

END OF SECTION 066400

SECTION 072100
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 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. Glass-fiber blankets.
- B. Related Requirements:
 - 1. Section 092900 "Gypsum Board" for sound attenuation blanket used as acoustic insulation.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. compliance must also state the range of total VOCs after 14 days, measured as specified in the CDPH Standard Method v1.1.

1.5 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.

PART 2 - PRODUCTS

2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD INSULATION (XPS)

- A. Extruded Polystyrene Board Insulation, Type X **<INSUL-1>**: ASTM C578, Type X, **15 psi (104 kPa)** minimum compressive strength; unfaced.

- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Owens Corning
 - 2. DuPont
 - 3. Kingspan
 - 4. Or equal as approved by the Professional.

2.2 POLYISOCYANURATE FOAM-PLASTIC BOARD INSULATION

- A. Polyisocyanurate Board Insulation, Foil Faced <INSUL-2>: ASTM C1289, foil faced, Type I, Class 1 or 2.

Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

- 1. Carlisle. (Basis of Design).
- 2. RMax
- 3. GAF
- 4. Or equal as approved by the Professional.

- B. Basis-of-Design Product:

- 1. Manufacturer: Carlisle
- 2. Product:

2.3 GLASS-FIBER BLANKET

- A. Glass-Fiber Blanket, Unfaced: 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. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - a. Rockwool
 - b. CertainTeed Corporation.
 - c. Johns Manville; a Berkshire Hathaway company.
 - d. Owens Corning
 - e. Or equal as approved by the Professional.

- B. EPD for Glass-Fiber Blanket: Provide an industry-wide EPD in accordance with ISO 14025 and has at least a cradle to gate scope.
- C. HPD for Glass-Fiber Blanket: Provide a complete Health Product Declaration with full disclosure of known hazards in compliance with the Health Product Declaration Open Standard.
- D. General Emissions Evaluation for Glass-Fiber Blanket: Provide third-party certified documentation of compliance with California Department of Public Health CDPH/EHLB/Standard Method Version 1.1, 2010.
- E. Recycled Content of Glass-Fiber Blanket: Provide documentation indicating postconsumer recycled content plus one-half of preconsumer recycled content.

2.4 ACCESSORIES

- A. Insulation for Miscellaneous Voids:
 - 1. Glass-Fiber Insulation: ASTM C 764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E 84.
- B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.
 - 1. VOC Emissions for Wet-Applied Adhesives: Provide certificate of compliance with California Department of Public Health (CDPH) Standard Method v1.1-2010, using the applicable exposure scenario.
 - 2. VOC Content for Wet-Applied Adhesives: Provide documentation of compliant VOC content per SCAQMD Rule 1168.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or 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.
- 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. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.3 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

- A. 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.
- B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
 1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft.

3.4 PROTECTION

- A. Protect installed insulation 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 072100

SECTION 072600
VAPOR RETARDERS

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. Polyethylene vapor retarders.
- B. Related Requirements:
 - 1. Section 033000 "Cast-in-Place Concrete" for under-slab vapor retarders.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

PART 2 - PRODUCTS

2.1 POLYETHYLENE VAPOR RETARDERS

- A. Polyethylene Vapor Retarders: ASTM D4397, 10-mil- (0.25-mm-) thick sheet, with maximum permeance rating of 0.1 perm (5.7 ng/Pa x s x sq. m).
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - a. Stego (Basis of Design)

- b. Owens Corning
- c. 3M
- d. Or equal as approved by the Professional.

2.2 ACCESSORIES

- A. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
- B. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and has demonstrated capability to bond vapor retarders securely to substrates indicated.
- C. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to vapor retarders, including removing projections capable of puncturing vapor retarders.

3.2 INSTALLATION OF VAPOR RETARDERS ON FRAMING

- A. Place vapor retarders on side of construction indicated on Drawings.
- B. Extend vapor retarders to extremities of areas to protect from vapor transmission. Secure vapor retarders in place with adhesives, vapor retarder fasteners, or other anchorage system as recommended by manufacturer. Extend vapor retarders to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.
- C. Seal vertical joints in vapor retarders over framing by lapping no fewer than two studs and sealing with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Locate all joints over framing members or other solid substrates.
- D. 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.
- E. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarders.

3.3 INSTALLATION OF VAPOR RETARDERS IN CRAWL SPACES

- A. Install vapor retarders over prepared grade. Lap joints a minimum of 12 inches (305 mm) and seal with manufacturer's recommended tape. Install second layer over pathways to equipment.
- B. Extend vapor retarder over footings and seal to foundation wall or grade beam with manufacturer's recommended tape.
 - 1. Extend vapor retarder vertically minimum 24 inches above top of footing.

- C. Seal around penetrations such as utilities and columns in order to create a monolithic, airtight membrane at grade surface, perimeter, and all vertical penetrations.

3.4 PROTECTION

- A. Protect vapor retarders from damage until concealed by permanent construction.

END OF SECTION 072600

SECTION 072715

SELF-ADHERING SHEET 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 self-adhering, vapor-retarding, modified bituminous sheet air barriers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For air-barrier assemblies.
 - 1. Include details for substrate joints and cracks, counterflashing strips, inside and outside corners, terminations, and tie-ins with adjoining construction.

1.4 INFORMATIONAL SUBMITTALS

- A. Product certificates.
- B. Product test reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by Manufacturer.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Content for Adhesives: Provide documentation of compliant VOC content per SCAQMD Rule 1168.

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 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.

2.3 SELF-ADHERING SHEET VAPOR PERMIABLE AIR BARRIER

- A. Self Adhering Sheet: Cross-laminated polyethylene film with release liner on adhesive side and formulated for application with primer that complies with VOC limits of authorities having jurisdiction.
 - 1. Products: Subject to compliance with requirements, products that may be incorporated into the work includethe following:
 - a. GCP Applied Technologies.; Perm-A-Barrier VPS Wall Membrane.
 - b. Henry Blueskin VP 160.
 - c. Or equal as approved by the Professional
 - 2. Physical and Performance Properties:
 - a. Air Permeance: Maximum 0.004 cfm/sq. ft.; ASTM E 2278.
 - b. Vapor Permeance: Minimum 10 perms; ASTM E 96.

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 membrane.
- B. Termination Mastic: Air-barrier manufacturer's standard cold fluid-applied elastomeric liquid; trowel grade.
- C. Termination Bar: Aluminum bar designed to cover exposed end of membrane.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

- A. Mask off adjoining surfaces not covered by air barrier to prevent damage to other construction.
- B. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.
- C. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D 4258.
- D. 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.

3.2 INSTALLATION

- A. General: Install modified bituminous sheets and accessory materials according to air-barrier manufacturer's written instructions and according to recommendations in ASTM D 6135.
 - 1. Do not install self-adhering sheet air barrier until it can be covered within 45 days of the commencement of installation.
 - a. Do not allow air barrier to be exposed to UV light for more than 45 days.
 - b. Air barrier must be fully protected or replaced after it has been exposed to UV light for more than 45 days.
- B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by air-barrier sheet on same day. Reprime areas exposed for more than 24 hours.
- C. Apply and firmly adhere modified bituminous sheets horizontally over area to receive air barrier. 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 airtight installation.
 - 1. Apply sheets in a shingled manner to shed water without interception by any exposed sheet edges.
 - 2. Roll sheets firmly to enhance adhesion to substrate.
- D. Seal top of through-wall flashings to air-barrier sheet.
- E. Provide termination bar at exposed edges of sheet not concealed by aluminum channels or other construction.
- F. Install air-barrier sheet and accessory materials to form a seal with adjacent construction and to maintain a continuous air barrier.
- G. At end of each working day, seal top edge of air-barrier material to substrate with termination mastic.
- H. Repair punctures, voids, and deficient lapped seams in air barrier. Slit and flatten fishmouths and blisters. Patch with air-barrier sheet extending 6 inches beyond repaired areas in all directions.
- I. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

END OF SECTION 072715

SECTION 074213

FORMED METAL WALL 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 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. Concealed-fastener, lap-seam metal wall panels.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Meet with metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of roofing, HVAC equipment and curbs.
 - 2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
 - 4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
 - 5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that affect metal panels.
 - 6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
 - 7. Review temporary protection requirements for metal panel assembly during and after installation.
 - 8. Review of procedures for repair of metal panels damaged after installation.
 - 9. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

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 for each type of panel and accessory.
- B. Shop Drawings:
 - 1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
 - 2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.
- C. Samples for Initial Selection: For each type of metal panel indicated with factory-applied finishes.
 - 1. Include Samples of trim and accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish, prepared on Samples of size indicated below:
 - 1. Metal Panels: 12 inches long by actual panel width. Include fasteners, closures, and other metal panel accessories.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- C. Sample Warranties: For special warranties.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal panels 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.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on metal panels during installation.

1.10 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.11 COORDINATION

- A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.12 WARRANTY

- A. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal 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: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:
 - 1. Wind Loads: As indicated on Drawings.
 - 2. Other Design Loads: As indicated on Drawings.
 - 3. Deflection Limits: For wind loads, no greater than 1/240 of the span.
- B. 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

- A. Flush-Profile, Concealed-Fastener Metal Wall Panels **MP-5**: Formed with vertical panel edges and intermediate stiffening ribs symmetrically spaced between panel edges; with flush joint between panels.
1. Metallic-Coate Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - a. Centria (Basis of Design).
 - b. McElroy
 - c. MBCI
 - d. Or equal as approved by the Professional.
 2. Basis-of-Design Product:
 - a. Manufacturer: Centria
 - b. Product: IW
 - c. Color: Charcoal Grey
 3. Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 (Z275) coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.
 - a. Nominal Thickness: 22 Gauge (0.76 mm)
 - b. Exterior Finish: Three-coat fluoropolymer
 - c. Color: As selected by Architect from manufacturer's full range
 4. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 (Z275) coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

2.3 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: 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 panel system.
- B. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
- C. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

2.4 FABRICATION

- A. General: Fabricate and finish metal 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. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.
- C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
- E. 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. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

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. Steel Panels and Accessories:
 - 1. Metallic Fluoropolymer: AAMA 621. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. 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 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 wall panel manufacturer.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal 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 panel manufacturer's written recommendations.

3.3 METAL PANEL INSTALLATION

- A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal 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 panels.
 2. Flash metal panels at perimeter of all openings. Fasten with self-tapping screws.
 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 panel work proceeds.
 6. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
- B. Fasteners:
 1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior.
- C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
- D. Lap-Seam Metal Panels: Fasten metal panels to supports with fasteners at each lapped joint at location and spacing recommended by manufacturer.
 1. Lap ribbed or fluted sheets one full rib. Apply panels and associated items true to line for neat and weathertight enclosure.
 2. Provide metal-backed washers under heads of exposed fasteners bearing on weather side of metal panels.
 3. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
 4. Install screw fasteners with power tools having controlled torque adjusted to compress washer tightly without damage to washer, screw threads, or panels. Install screws in predrilled holes.
 5. Flash with weather closures at perimeter of all openings.

- E. 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 panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal wall panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.
- F. 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 achieve 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.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect completed metal wall panel installation, including accessories.
- B. Remove and replace metal wall panels where tests and inspections indicate that they do not comply with specified requirements.
- C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

3.5 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
- B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074213

SECTION 074213.19

INSULATED CORE METAL WALL PANELS

PART 1 - GENERAL

1.1 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.

SECTION INCLUDES

- A. Foamed-insulation-core vertical metal wall panel assembly, with related metal trim and accessories.

1.2 RELATED REQUIREMENTS

- A. Division 07 Section "Sheet Metal Flashing and Trim" for sheet metal copings, flashings, reglets and roof drainage items not specified in this Section.
- B. Division 07 Section "Joint Sealants" for field-applied joint sealants.
- C. Section 074293 "Soffit Panels" for metal panels used in horizontal soffit applications.

1.3 REFERENCES

- A. American Architectural Manufacturers Association (AAMA):
 - 1. AMMA 501.1 - Standard Test Method for Water Penetration of Exterior Walls Using Dynamic Pressure
 - 2. AAMA 501.2 - Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtainwalls and Sloped Glazing Systems.
 - 3. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.
 - 4. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
- B. American Society of Civil Engineers (ASCE):
 - 1. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.
- C. ASTM International (ASTM):
 - 1. ASTM A 653/A 653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc/Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 2. ASTM A 755/A 755M - Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products.
 - 3. ASTM B 117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
 - 4. ASTM C 920 - Specification for Elastomeric Joint Sealants.
 - 5. ASTM C 1363 - Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus.
 - 6. ASTM D 968 - Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive.

7. ASTM D 4585 - Standard Practice for Testing Water Resistance of Coatings Using Controlled Condensation.
 8. ASTM D 4587 - Standard Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings.
 9. ASTM E 72 - Standard Test Methods of Conducting Strength Tests of Panels for Building Construction.
 10. ASTM E 84 - Test Methods for Surface Burning Characteristics of Building Materials.
 11. ASTM E 119 - Test Methods for Fire Tests of Building Construction and Materials.
 12. ASTM E 283 - Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences across the Specimen.
 13. ASTM E 330 - Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
 14. ASTM E 331 - Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
- E. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA):
1. Architectural Sheet Metal Manual.
- F. Underwriters Laboratories, Inc. (UL):
1. UL 263 - Fire Tests of Building Construction and Materials.
 2. CAN/ULC-S101 - Standard Methods of Fire Endurance Tests of Building Construction and Materials.
 3. CAN/ULC-S102 - Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 4. CAN/ULC-S134 - Standard Method of Fire Test of Exterior Wall Assemblies.
- G. National Fire Protection Agency (NFPA)
1. NFPA 285 - Evaluation of Fire Propagation Characteristics of Exterior Non-Load Bearing Wall Assemblies.
 2. NFPA 286 - Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth.
 3. NFPA 259 - Standard Test Method for Potential Heat of Building Materials
- 1.4 PERFORMANCE REQUIREMENTS
- A. General: Provide metal wall panel system meeting performance requirements as determined by application of specified tests by a qualified testing agency on manufacturer's standard assemblies.
 - B. Air Infiltration: Maximum 0.01 cfm/sq. ft. (0.5 L/s per sq. m) per ASTM E 283 at a static-air pressure difference of 6.24 lb. /sq. ft. (299 Pa), using minimum 10-by-10-foot (3048 by 3048 mm) test panel assembly that includes horizontal and vertical joints.
 - C. Water Penetration, Static Pressure: No uncontrolled water penetration per ASTM E 331 at a minimum static differential pressure of 15 lb./sq. ft. (718 Pa) for 15 minutes using minimum 10-by-10-foot (3048-by-3048 mm) test panel assembly that includes horizontal and vertical joints.
 - D. Water Penetration, Static Pressure - 2-hour duration: Panel system shall demonstrate no water penetration when tested in accordance with ASTM E331 at 6.24 lb/sq. ft. (299 Pa) pressure differential for a two (2) hour duration to satisfy International Building Code (IBC), Section 1403.2. Panel systems unable to demonstrate compliance with this requirement will require a separate

weather-resistive barrier, approved by CENTRIA for fire performance, installed behind the wall panel system to comply with IBC requirements.

- E. Water Penetration, Dynamic Pressure: No uncontrolled water penetration per AAMA 501.1 at a minimum dynamic differential pressure of 15 lb./sq. ft. (718 Pa) for 15 minutes using minimum 10-by-10-foot (3048-by-3048 mm) test panel assembly that includes horizontal and vertical joints.
 - F. Structural Performance: Provide metal wall panel assemblies capable of withstanding the effects of indicated loads and stresses within limits and under conditions indicated, per ASTM E 72:
 - 1. Seismic Performance: Allow for panel movement under seismic loads without damage or failure of the panel system.
 - 2. Secondary Metal Framing: Design secondary metal framing according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions." Provide minimum 4-inch- (102-mm-) wide bearing surface for metal wall panels at vertical end joints
 - G. Thermal Movements: Allow for thermal movements from variations in both ambient and internal temperatures. Accommodate movement of support structure caused by thermal expansion and contraction
 - H. Thermal Performance: Thermal-resistance (R) value indicated, per ASTM C 1363, corrected for air film with dynamic wind perpendicular to panel and still air inside.
 - I. Fire Performance Characteristics: Provide metal wall composite wall systems that comply with the performance requirements of Chapter 26 Plastic of the International Building Code.
- 1.5 QUALITY ASSURANCE
- A. Manufacturer/Source: Provide metal wall panel assembly and accessories from a single manufacturer.
 - B. Installer Qualifications: Experienced Installer with minimum of 5 years' experience with successfully completed projects of a similar nature and scope.
 - C. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as specified in Division 07 Section "Joint Sealants."
- 1.6 ADMINISTRATIVE REQUIREMENTS
- A. Preinstallation Meeting: Prior to erection of wall framing, conduct preinstallation meeting at site attended by Owner, Architect, manufacturer's technical representative, and other trade contractors.
 - 1. Coordinate building framing in relation to Metal Wall Panel system.
 - 2. Coordinate windows, doors, and other openings and penetrations of metal wall panel system.
- 1.7 ACTION SUBMITTALS
- A. Product Data: Manufacturer's data sheets for specified products.
 - B. Shop Drawings: Provide shop drawings prepared by manufacturer or manufacturer's authorized dealer. Include full elevations showing openings and penetrations. Include details of each condi-

tion of installation and attachment. Provide details at a minimum scale 1-1/2-inch per foot of all required trim and extrusions needed for a complete installation

1. Include data indicating compliance with performance requirements.
2. Indicate points of supporting structure that must coordinate with metal wall panel system installation.
3. Include structural data indicating compliance with performance requirements.

C. Samples for Initial Selection: For each product specified including sealants and gaskets. Provide representative color charts of manufacturer's full range of colors.

D. Samples for Verification: Provide 12-inch- (305 mm-) long section of metal wall panel showing finishes, vertical joint return, injected core material, and anchoring details. Provide 14-inch- (356 mm-) long pieces of each extruded aluminum trim and gaskets.

1.8 INFORMATIONAL SUBMITTALS

A. Product Performance Summary: Indicating compliance of products with requirements, from a qualified independent testing agency.

B. Special Manufacturer's Warranty: On manufacturer's standard form, in which manufacturer agrees to repair or replace metal wall panel assemblies [and integrated window units] that fail in materials and workmanship within [two] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Insulated Core Metal Wall Panel System: Factory-foamed-in-place vertical wall panel system consisting of an exterior metal face sheet with interior metal liner panel, bonded to factory foamed-in-place core in thermally-separated profile, with factory sealed tongue-and-groove side joint, attached to supports using concealed fasteners.

~~B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following—Subject to compliance with requirements, provide the following:~~

~~1. CENTRIA-Versawall (Basis of Design)~~

~~4-2. Kingspan~~

~~2-3. Atas-Isoleren ML~~

~~4. Or equal as approved by Professional~~

A. Basis of Design:

1. CENTRIA Versawall Insulated Core Metal Wall Panels.-
2. MP-1 Versawall H, 3" thick, 36" wide Color-Green Moss
3. MP-2 Versawall V, 2 3/4" thick, 36" wide: Color-Limestone
4. MP-3 Versawall H, 3" thick, 36" wide; Color-Charcoal
5. MP-4 Versawall V, 2 3/4" thick, 36" wide: Color-Charcoal

2.3 PANEL MATERIALS

A. Metallic Coated Steel Sheet: Zinc-Coated (Galvanized) Steel Sheet ASTM A 653/A 653M, Grade 37, G90, structural quality coil coated per ASTM A 755/A 755M.

B. Exposed Coil-Coated Finish:

1. Fluoropolymer Two-Coat System: 0.8 mil primer with 0.8 mil 70 percent PVDF fluoropolymer color coat, AAMA.

C. Interior Face Sheet Coil-Coated Finish System: 0.2 mil primer with 0.6 mil acrylic color coat.

2.4 INSULATION FOR PANEL CORES

A. Metal Panel Foamed-Insulation Core: Closed cell, isocyanurate foam using a non-CFC blowing agent, foamed-in-place type.

1. Density: 3.0 +/- 0.5 pcf./cu. ft. (48.1 kg/cu. m).
2. Shear stress: >20 lb./sq. in. (138 kPa).
3. Compressive strength: >20 lb./sq. in. (138 kPa).
4. Tensile strength: >20 lb./sq. in. (138 kPa).

2.5 FOAMED-INSULATION-CORE METAL WALL PANELS

A. Concealed Fastener, Foamed-Insulation-Core Metal Wall Panels: Factory-foamed vertical wall panel system consisting of an exterior metal face sheet with interior metal liner panel, bonded to factory foamed-in-place core in thermally-separated profile, with no glues or adhesives, and with factory sealed double tongue-and-groove joint, attached to supports using concealed fasteners.

1. Exterior Face Sheet:

- a. Metal Thickness: 0.036 inch/20 gage (0.91 mm)
- b. Versawall V+ Surface: Non-Embossed, Flat,
- c. Color: [As indicated] [As selected by Architect from manufacturer's standard colors] [Match Architect's custom color].

2. Interior Face Sheet:

- a. Thickness: [0.019 inch/26 gage (0.48 mm)] [0.024 inch/24 gage (0.60 mm)] [0.030 inch/22 gage (0.76 mm)] [0.036 inch/20 gage (0.91 mm)].
- b. Surface: Embossed, Planked.
- c. Color: As indicated
- d.

3. Panel Width: 36 inch (914 mm) UON

4. Panel Thickness and Thermal Resistance (R) Value: [2.0 inch (51 mm), R-16.7] [2.75 inch (70 mm), R-23.0] [3" flat - R-24] [4.00 inch (102 mm), R-33.5] per ASTM C 518.

5. Panel Sealant/Vapor Seal: Factory-applied non-curing butyl.

6. Panel Reveals: 0.5" reveal

7. Panel Reveal Depth: Horizontal panel reveal depth to be a minimum of 1-3/16"

8. Horizontal Panel - Side Joint: Side joints with positive drip edge, sloped drain shelf and integral venting to the exterior along the panel length to permit moisture drainage.

9. Horizontal Panel – End Joint: End joint shall be [Extrusions] [Flashings] or [Gaskets with field formed folded (trimless) ends], exposed wet seals are not permitted.

10. Outer wings of gasket shall compress against the trimless end of the panel face. A continuous back-up flash behind the end joint is required with two beads of field applied non-curing butyl sealant between the panel and back up flashing for each panel.

2.6 METAL WALL PANEL ACCESSORIES

A. General: Provide complete metal wall panel assembly incorporating trim, copings, fasciae, parapet caps, soffits, sills, inside and outside corners, and miscellaneous flashings. Provide manufacturer's factory-formed clips, shims, flashings, gaskets, lap tapes, closure strips, and caps for a complete installation. Fabricate and install accessories in accordance with SMACNA Manual.

B. Formed Flashing and Trim: Match material, thickness, and finish of the metal wall panel face sheet.

- C. Extrusion Trim: Provide manufacturer-provided extruded trim for the following locations and as indicated on Drawings:
 - 1. Base trim.
 - 2. Coping.
 - 3. Panel installation perimeter.
 - 4. Opening perimeters.
- D. Sealants: Type recommended by metal wall panel system manufacturer for application, meeting requirements of Division 07 Section "Joint Sealants."
- E. Panel Clips: Concealed galvanized steel clip configured specifically for metal wall panel profile, engaging face and liner panel edge without compressing panel insulation.
- F. Fasteners: Self-tapping screws, bolts, nuts, and other acceptable fasteners recommended by panel manufacturer. Where exposed fasteners cannot be avoided, supply corrosion-resistant fasteners with heads matching color of metal wall panels.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine metal wall panel system substrate with Installer present. Inspect for erection tolerances and other conditions that would adversely affect installation of metal wall panels.
- B. Wall Substrate: Confirm that wall substrate is within tolerances acceptable to metal wall panel system manufacturer.
 - 1. Maximum deviations acceptable:
 - 2. 1/4 inch (9.5 mm) in 20 foot (610 cm) vertically or horizontally from face plane of framing.
 - 3. 1/2 inch (19 mm) on any building elevation. Within 1/8" in transition areas.
- C. Framing: Inspect framing that will support metal wall panels to determine if support components are installed as indicated on approved shop drawings. Confirm presence of acceptable framing members at recommended spacing to match installation requirements of metal wall panels.
- D. Openings: Verify that windows, doors, louvers and other penetrations match layout on shop drawings.
- E. Advise G.C., in writing, of all out- of-tolerance work and other deficient conditions prior to proceeding with metal wall panel installation.
- F. Correct out of tolerance work and other deficient conditions prior to proceeding with insulated composite backup panel installation.

3.2 METAL WALL PANEL SYSTEM INSTALLATION

- A. General: Install metal wall panel system in accordance with approved shop drawings and manufacturer's recommendations. Install metal wall panels in orientation, sizes, and locations indicated. Anchor metal wall panels and other components securely in place. Provide for thermal and structural movement

- B. Attach panels to metal framing using recommended clips, screws, fasteners, sealants, and adhesives indicated on approved shop drawings.
 - 1. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated or, if not indicated, as approved by manufacturer.
 - 2. Fasten metal wall panels to supports with concealed clips at each joint at location, spacing, and with fasteners recommended by manufacturer. Install clips to supports with self-tapping fasteners.
 - 3. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.
 - 4. Dissimilar Materials: Where elements of metal wall panel system will come into contact with dissimilar materials, treat faces and edges in contact with dissimilar materials as recommended by manufacturer.
- C. Joint Sealers: Install joint fillers and sealants where indicated and where required for weatherproof performance of metal wall panel assemblies.
 - 1. Seal panel end utilizing 2 beads of non-curing butyl; apply continuously without gaps to complete panel system air barrier.
 - 2. Seal metal wall panel to supports or back-up flashing sealant, full width of panel. Seal side joints where recommended by metal wall panel manufacturer.
 - 3. Prepare joints and apply sealants per Division 07 Section "Joint Sealants."

3.3 ACCESSORY INSTALLATION

- A. General: Install metal wall panel accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
 - 1. Install related flashings and sheet metal trim of Division 07 Section "Sheet Metal Flashing and Trim."
 - 2. Install components required for a complete metal wall panel assembly, including trim, copings, corners, flashings, sealants, gaskets, fillers, closure strips, and similar items.
 - 3. Comply with performance requirements and manufacturer's written installation instructions.
 - 4. Provide concealed fasteners except where noted on approved shop drawings.
 - 5. Set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

3.4 INTEGRATED UNIT INSTALLATION

- A. Install window units in accordance with manufacturer's recommendations and approved shop drawings. Assemble wall components using gaskets, fasteners, and trim supplied by metal wall panel manufacturer. Separate dissimilar metals with manufacturer's approved coating.

3.5 FIELD QUALITY CONTROL

- A. The panel installer shall water test panel [and window] areas for each crew at least twice during installation schedule and once at the conclusion of the installation.
- B. Progress or check tests can be performed by the installer following test procedures noted in AAMA 501.2. No independent test agency needs to be employed in this test phase. Results of this test phase is to be recorded and reported to the panel manufacturer.
- C. Final AAMA 501.2 testing will be conducted by an independent test agency following project completion. Areas of test are to be determined by the Architect/Engineer and General Contractor/Contract Manager and the panel installer. Engagement of the test agency is the responsibility of the General Contractor/Contract Manager.

ity of the [GC/CM] [panel installer]. A field representative from the panel manufacturer is required for the final inspection and testing.

3.6 CLEANING AND PROTECTION

- A. Remove temporary protective films within 2 weeks of erection. Clean finished surfaces as recommended by metal wall panel manufacturer. Clear weep holes and drainage channels of obstructions, dirt, and sealant. Maintain in a clean condition during construction.
- B. Replace damaged panels and accessories that cannot be repaired by field repair.

SECTION 075423
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. Thermoplastic-polyolefin (TPO) roofing system.
- B. Related Requirements:
 - 1. Division 06 Section "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
 - 2. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
 - 3. Section 077200 "Roof Accessories" for manufactured roof accessory units.
 - 4. Division 07 Section "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
 - 5. Division 22 and 23 Sections.

1.3 DEFINITIONS

- A. Roofing Terminology: Definitions in ASTM D 1079 and glossary of 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. Contractor shall utilize the Pre-Installation Meeting Agenda and Pre-Installation Meeting Checklist documents in the Z Standard Training & Documentation: Documents / 03 – Construction – Training and Guidance Documents / 03 – Role Based Training and Guidance Documents / Contractors.
 - 1. Meet with Client Agency, Professional, Client Agency's insurer (if applicable), testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
 - 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 roofing, fastening spacings, and patterns for mechanically fastened roofing.
 - 4. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
- C. Samples for Verification: For the following products:
 - 1. Sheet roofing, of color required.

1.6 INFORMATIONAL SUBMITTALS

- A. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
 - 1. Submit evidence of complying with performance requirements.
- B. 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: 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.
- B. The Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to perform work under warranty for existing roof assembly. 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.

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 deflection of deck.

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 WARRANTIES:

A. ROOFING WARRANTY - 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 Owner 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. Warranty Wind Speed Coverage: 90-mph.
3. 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.
4. 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.
5. 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 dollar limit to the warrantor's liability for making such repairs over the period of the warranty.
6. 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.
7. 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.

PART 2 - PRODUCTS

- A. Source Limitations: Obtain components including roof insulation, fasteners, and roofing accessories 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 152, ASTM G 154, or ASTM G 155.

- 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.

2.3 THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

- A. TPO Sheet: ASTM D6878/D6878M, internally scrim-reinforced TPO sheet.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include,-the following:
 - 1. Carlisle Syntec. (Basis of Design).
 - 2. John Mansville
 - 3. GAF
 - 4. Or equal as approved by the Professional.
- C. Basis-of-Design Product:
 - 1. Manufacturer: Carlisle Syntec
 - 2. Product: Sureweld
 - 3. Thickness: 80 mils.
 - 4. Color: White.

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, 55 mils thick, minimum, of same color as TPO sheet.
- C. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.
- D. Bonding Adhesive: Manufacturer's standard, 3-inch wide minimum.
- E. Lap Sealant: Manufacturer's standard, single-component sealant, colored to match membrane roofing.
- F. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.
- G. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
- H. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening membrane to substrate, and acceptable to roofing system manufacturer.
- I. Miscellaneous Accessories: Provide 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 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 and that produce FM Global-approved roof insulation.
- B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces
 - 1. Compressive strength: 20 psi.
 - 2. Thickness:
 - a. (2) layers 2.6-inch, R-30 min.
- 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.

2.6 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 and cover boards to substrate, and acceptable to roofing system manufacturer.
- C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
- D. Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/2 inch thick, factory primed.

2.7 ROOF CURBS

- A. Roof Curbs: Internally reinforced roof-curb units 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, and integrally formed deck-mounting flange at perimeter bottom.
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Pate Company (Basis of Design).
 - b. Thybar Corporation.
 - c. FW Webb
 - d. Or equal as approved by the Professional.
- B. Material: Zinc-coated (galvanized) steel sheet, 0.079 inch thick.
 - 1. Finish: Mill phosphatized.
- C. Construction:

1. Insulation: Factory insulated with 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. Fabricate curbs to height indicated on drawings.
5. Top Surface: Sloped to drain away from roof penetration.

D. MISCELLANEOUS MATERIALS

1. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
2. 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.
3. 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.
4. Sealants: As recommended by roof accessory manufacturer for installation indicated.

2.8 ROOF FLASHING

- A. Stainless-Steel Sheet: ASTM A 240 or ASTM A 666, Type 304, dead soft, fully annealed; 2D (dull, cold rolled) finish.
- B. Solder:
 1. For Stainless Steel: ASTM B 32, Grade Sn60, with an acid flux of type recommended by stainless-steel sheet manufacturer.
- C. Elastomeric Sealant: ASTM C 920, elastomeric polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

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 053100 "Steel Decking."
 4. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
 5. Photographs or Videotape: Document existing conditions of adjoining construction and roof decking. Submit before work begins.
- B. Proceed with installation only after unsatisfactory conditions have been corrected. Start of installation will be construed as acceptance of existing substrate conditions.

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.
- C. Protect building to be reroofed, adjacent buildings, walkways, site improvements, exterior plantings, and landscaping from damage or soiling from reroofing operations.

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.

3.4 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 inches or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 12 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 and Adhered Insulation: Install first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
 - 1. Fasten first layer of insulation according to requirements in FM Global's "RoofNav" for specified Windstorm Resistance Classification.
 - 2. Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.

3. Set each subsequent layer of insulation in a uniform coverage of full-spread or bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
- H. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction. Loosely butt cover boards together.
1. Adhere cover board to substrate using adhesive according to manufacturer's requirements and FM Global's "RoofNav" for specified Windstorm Resistance Classification.
 2. Adhere cover boards to resist uplift pressure at corners, perimeter, and field of roof.
 3. Set cover board in a uniform coverage of full-spread or bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.

3.5 ADHERED MEMBRANE ROOFING INSTALLATION

3.6 INSTALLATION OF ADHERED ROOF MEMBRANE

- A. Adhere roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.
 - B. Unroll roof membrane and allow to relax before installing.
 - C. Start installation of roofing in presence of roofing system manufacturer's technical personnel.
 - D. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- A. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer, and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, and perimeter of roofing.
- B. Apply membrane roofing with side laps shingled with slope of roof deck where possible.
- C. Seams: Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane 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 membrane.
 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 does not comply with requirements.
- D. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.

3.7 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 splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.8 ROOF CURB INSTALLATION

- A. General: Verify dimensions of roof openings for roof accessories. 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. Coat concealed side of metal roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 - 2. 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.
- C. Seal joints with sealant as required by roof accessory manufacturer.

3.9 ROOF FLASHING INSTALLATION

- A. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending a minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.
- B. 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 a minimum of 4 inches and bed with sealant.
- C. 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.

3.10 FIELD QUALITY CONTROL

- A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion for warranty purposes.
- B. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.
- C. Perform additional testing and inspecting until replaced or additional work complies with specified requirements.

3.11 PROTECTING AND CLEANING

- A. Protect membrane 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 the Architect and Owner.
- B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates, and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

END OF SECTION 075323

SECTION 076200

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 wall sheet metal fabrications.
 - 3. Formed equipment support flashing.
- B. Related Requirements:
 - 1. Division 4 Sections
 - 2. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
 - 3. Section 077200 "Roof Accessories"
 - 4. Section 079200 "Joint Sealants"

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 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 manufactured product and accessory.
- B. Shop Drawings: For sheet metal flashing and trim.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Detail joint locations and keyed details. Distinguish between shop- and field-assembled work.
 - 3. Include details of roof-penetration flashing.
 - 4. Include details of edge conditions and counterflashings as applicable.
 - 5. Include details of special conditions.

- 6. Include details of connections to adjoining work.
- C. 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.
- 1.5 CLOSEOUT SUBMITTALS
 - A. Maintenance Data.
- 1.6 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.
- 1.7 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. Store Tin Zinc copper sheets, coils and formed shapes off the ground, in an enclosed structure. Do not store in a manner or location so that the water or moisture may remain between sheets or shapes prior to installation. Do not store on bare ground under a tarp or in other manner that may cause condensation to form on or between sheets or shapes. Handle sheets and shapes in a manner to reduce scratches, dents, etc.
 - C. 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.

PART 2 - PRODUCTS

- 2.1 SHEET METALS
 - A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
 - B. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, dead soft, fully annealed; with dull, cold rolled surface.
 - C. Tin Zinc Copper Sheet (TZC): ASTM B370 copper sheet, coated both sides with zinc/tin alloy .5 mills thick, applied by hot-dip process. Manufactured by Revere Copper Products Inc.
 - D. Recycled Content: Provide documentation indicating postconsumer recycled content plus one-half of preconsumer recycled content.

2.2 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, masonry anchors, 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. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal.
 - 2. 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.
 - 2. For Tin Zinc Copper: ASTM B 32, pure tin or lead-free high tin.
- 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: Refer to Division 07 Section "Joint Sealants"
- F. Recycled Content: Provide documentation indicating postconsumer recycled content plus one-half of preconsumer recycled content.

2.3 MANUFACTURED SHEET METAL FLASHING AND TRIM

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Soprema
 - 2. Metal Era
 - 3. Atas
 - 4. Or equal as approved by the Professional.
- B. Basis-of-Design Product:
 - 1. Manufacturer: Soprema
 - 2. Product:
- C. Reglets: Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctions and with interlocking counterflashing on exterior face, of same metal as reglet.
 - 1. Material: Stainless steel, 0.019 inch thick.
 - 2. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
 - 3. Accessories:

- a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
- b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing's lower edge.

4. Finish: Mill.

2.4 FABRICATION, GENERAL

- A. Sheet Metal Flashing and Trim: Fabricate flashing and trim following recommendations in Revere Copper Products, Inc. "Copper and Common Sense" and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of items 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: Fabricate rigid seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 - 3. Sealed Joints: Solder joints to maximum extent possible.
 - 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.
 - a. Size: As recommended by Revere Copper Products, Inc. "Copper and Common Sense" or SMACNA's "Architectural Sheet Metal Manual" for application, but not less than thickness of metal being secured.

2.5 ROOF-DRAINAGE SHEET METAL FABRICATIONS

- A. Downspouts & Gutters: Fabricate to dimensions shown on drawings. Fabricate from the following materials:
 - 1. Tin Zinc Copper: 20-ounce, 0.027 inch thick.
 - 2. Install gutter expansion joints midway between downspouts.

2.6 FLAT 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.
 - 1. Joint Style: Overlapped, 4 inches wide.
 - 2. Material: Tin Zinc Copper: 16-ounce, 0.0216 inch thick.
- B. Counterflashing, Flashing Receivers, Roof Penetration Flashing: Shop fabricate interior and exterior corners. Fabricate from the following materials:
 - 1. Stainless Steel: 0.019 inch thick.

- C. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch-long, but not exceeding 12-foot-long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of wall openings; and form with 2-inch-high, end dams. Fabricate from the following materials:

- 1. Stainless Steel: 0.016 inch thick.

- D. Equipment support flashings:

- 1. Stainless Steel: 0.016 inch thick.

2.7 GABLE ROOF SHEET METAL FABRICATIONS

- A. Fabricate flashings from the following materials as shown on drawings:

- 1. Tin Zinc Copper: 16-ounce, 0.0216 inch thick.

2.8 MISCELLANEOUS SHEET METAL FABRICATIONS

- A. Fabricate from the following materials as shown on drawings:

- 1. Stainless Steel: 0.019 inch thick.

- 2. Tin Zinc Copper: 16-ounce, 0.0216 inch 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 that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
 - 2. 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. Start of installation will be construed as acceptance of existing substrate conditions.

3.2 UNDERLAYMENT INSTALLATION

- A. 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.

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.
- 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 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.
- D. Fasteners: Use fastener sizes that penetrate wood blocking or substrate not less than 1-1/4 inches.
- 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. 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 079200 "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 use torches for soldering.
2. Heat surfaces to receive solder, and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
3. 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.
4. Zinc Copper Soldering: Before soldering Z-T Alloy coated copper, the pre-weathered coating must be removed and surfaces to receive soldering chemically and/or mechanically cleaned to produce clean, bright alloy. To ease soldering, a tin-bearing flux may be applied to all surfaces to receive solder.

3.4 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, 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 FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals' listing for required windstorm classification.
- C. 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.
- D. 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.
- E. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with butyl sealant and clamp flashing to pipes that penetrate roof.

3.5 WALL FLASHING INSTALLATION

- A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

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.

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 and neutralize flux materials. Clean off excess solder and sealants.
- B. 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.
- C. Tin Zinc Copper shall be protected during installation and cleaning of masonry with tarps, polyethylene sheeting, or similar impervious materials. To prevent water stains due to condensation trapped on metal's surface, protection must be removed at the end of each workday.
- D. Remove excessive dirt and construction debris from Tin Zinc Copper by washing thoroughly with clear water. Grease, oils, etc., may be removed by washing with alkaline commercial cleaning agent in hot water. Do not otherwise chemically or mechanically clean Tin Zinc Copper.

END OF SECTION 076200

SECTION 077100
ROOF 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. Manufactured Metal Coping System.

- B. Related Requirements:

1. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 076200 "Sheet Metal Flashing and Trim" for custom- and site-fabricated sheet metal flashing and trim.
3. Section 079200 "Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.

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.

- B. Shop Drawings: For roof specialties.

1. Include details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
2. Indicate profile and pattern of seams and layout of fasteners, cleats, clips, and other attachments.
3. Include details of special conditions.

- C. Samples for Verification:

1. Include Samples of each type of roof specialty to verify finish and color selection, in manufacturer's standard sizes.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roofing specialties to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer offering products meeting requirements that are FM Approvals listed for specified class.
- B. Source Limitations: Obtain roof specialties approved by manufacturer providing roofing-system warranty specified in Section 075323 "Ethylene-Propylene-Diene-Monomer (EPDM) Roofing".

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.
- B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof-specialty installation.

1.8 FIELD CONDITIONS

- A. Field Measurements: Verify profiles and tolerances of roof-specialty substrates by field measurements before fabrication, and indicate measurements on Shop Drawings.
- B. Coordination: Coordinate roof specialties with flashing, trim, and construction of parapets, roof deck, roof and wall panels, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
 - 1. Warranty includes components of coping system.
 - 2. Warranty Period: 20 years from date of Substantial Completion.
- B. Special Warranty on Painted Finishes: Manufacturer agrees to repair finish or replace roof specialties 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: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof specialties 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.
- B. SPRI Wind Design Standard: Manufacture and install copings tested according to SPRI ES-1 and capable of resisting the design pressures indicated on the drawings.
- C. 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 sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. 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.

2.2 COPINGS

- A. Metal Copings: Interlocking, multi-part manufactured coping system consisting of metal coping cap in section lengths not exceeding 12 feet, concealed anchorage, corner and end cap units, and concealed splice plates with finish matching coping caps.
 - 1. 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:
 - a. Metal-Era.
 - b. Hickman Engineered Systems.
 - c. Petersen Aluminum Corporation.
 - d. SAF Perimeter Systems.
 - e. Or equal as approved by the Professional.
 - 2. Basis-of-Design Product:
 - a. Manufacturer: Metal-Era.
 - b. Product: Perma-Tite Continuous Cleat Coping.
 - 3. Formed Aluminum Sheet Coping Caps: Aluminum sheet, 0.050 inch thick.
 - a. Surface: Smooth, flat finish.
 - b. Finish: Two-coat fluoropolymer.
 - c. Color: As selected by the Professional from manufacturer's full range.

2.3 ROOF-EDGE SPECIALTIES

- A. Decorative Metal Roof-Edge Gravel Stop GS-1: Manufactured, two-piece, roof-edge fascia consisting of compression-clamped metal fascia cover in section lengths not exceeding [**12 ft. (3.6 m)**] and a continuous formed galvanized-steel sheet cant, 0.039 inch (1.0 mm) thick, minimum, with pre-punched slotted holes and extended vertical leg terminating in a drip-edge cleat. Provide matching corner units.

B.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Atas- Basis of Design
 - b. Metal Era.
 - c. Hickman Engineered Systems.
 - d. Petersen Aluminum Corporation.
 - e. SAF Perimeter Systems.
 - f. Or equal as approved by the Professional.
2. Basis-of-Design Product:
 - a. Manufacturer: Atas
 - b. Product: Gravel Stop
3. Corners: Factory mitered and mechanically clinched and sealed
4. Splice Plates: Concealed, of same material, finish, and shape as fascia cover.

2.4 ROOF-EDGE DRAINAGE SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
1. Atas-(Basis of Design)
 2. Hickman Edge Systems.
 3. Metal-ERA, Inc.
 4. Or equal as approved by the Professional
- B. Gutters: Manufactured in uniform section lengths. minimum [12 ft. (3.6 m)] with matching corner units, ends, outlet tubes, and other accessories. Tested per ANSI/SPRI GT-1 to resist specified design pressures. Elevate back edge at least 1 inch (25 mm) above front edge. Furnish flat-stock gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.
1. Zinc-Coated Steel: Nominal 0.040-inch thickness.
 2. Gutter Profile: As indicated in accordance with SMACNA's "Architectural Sheet Metal Manual."
 3. Corners: Factory mitered and clinched and sealed watertight
 4. Gutter Supports: Straps with finish matching the gutters.
- C. Downspouts: rectangular complete with mitered elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.
1. Zinc-Coated Steel: Nominal 22 gauge
- D. Zinc-Coated Steel Finish: Two-coat fluoropolymer
1. Color: Match Architect's sample

2.5 REGLETS AND COUNTERFLASHINGS

- A. Manufacturers two-piece system with receiver and snap-in skirt with reglet installation Counter flashing is provided in 12-ft. (3.66 m) lengths, pre-punched for fasteners, and is available in a range of materials, gauges, and colors. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

1. Hickman Edge Systems- Basis of Design
 2. Metal-ERA, Inc.
 3. Soprema
 4. Or equal as approved by the Professional.
- B. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:
1. Zinc-Coated Steel: Nominal 0.023-inch (0.56-mm) thickness.
- C. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches (100 mm) and in lengths not exceeding 12 ft. (3.6 m) designed to snap into reglets and compress against base flashings with joints lapped, from the following exposed metal:
1. Zinc-Coated Steel: Nominal 0.023-inch (0.56-mm)] thickness.
- D. Accessories:
1. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where reglet is provided separate from metal counterflashing.
 2. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.
- E. Zinc-Coated Steel Finish: Two-coat fluoropolymer
1. Color: Match Architect's sample

2.6 MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 (Z275) coating designation.
- B. Aluminum Sheet: ASTM B 209 alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.
1. Corners: Factory mitered and continuously welded.
 2. Coping-Cap Attachment Method: face leg hooked to continuous cleat with back leg fastener exposed, fabricated from coping-cap material.
 - a. Snap-on Coping Anchor Plates: Concealed, galvanized-steel sheet, 12 inches wide, with integral cleats.
 - b. Face-Leg Cleats: Concealed, continuous

2.7 MISCELLANEOUS MATERIALS

- A. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:
1. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.
 2. Fasteners for Copper Sheet: Copper, hardware bronze, or passivated Series 300 stainless steel.
 3. Fasteners for Aluminum: Aluminum or Series 300 stainless steel.

4. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
 5. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel in accordance with ASTM A153/A153M or ASTM F2329.
- B. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.
 - C. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type joints with limited movement.
 - D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
 - E. Asphalt Roofing Cement: ASTM D4586, asbestos free, of consistency required for application.

2.8 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted 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 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.
 1. Two-Coat Fluoropolymer: AAMA 621. 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, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.
- C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage where applicable, and securely anchored.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, underlayments, sealants, and other miscellaneous items as required to complete roof-specialty systems.

1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
 2. Provide uniform, neat seams with minimum exposure of solder and sealant.
 3. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
 4. Torch cutting of roof specialties is not permitted.
- 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. Coat concealed side of uncoated aluminum roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.
- C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.
1. Space movement joints at a maximum of 12 feet with no joints within 18 inches of corners or intersections unless otherwise indicated on Drawings.
 2. 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.
- D. Fastener Sizes: Use fasteners of 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. Seal concealed joints with butyl sealant as required by roofing-specialty manufacturer.
- F. Seal joints as required for weathertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F.

3.3 COPING INSTALLATION

- A. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.
- B. Anchor copings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.
1. Interlock face and back leg drip edges of snap-on coping cap into cleated anchor plates anchored to substrate at 30 inch centers.

3.4 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.
- B. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077100

SECTION 077200

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.
- B. Related Sections:
 - 1. Refer to Division 01 "Sustainable Design Requirements" for VOC and Emissions of exterior applied products.
 - 2. Refer to Mechanical drawing for parapet drainage units and rainwater conductors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of roof accessory indicated.
- B. Shop Drawings: For roof accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.6 QUALITY ASSURANCE

- A. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.

1.7 WARRANTY

- A. Provide the manufacturer's warranty specified under products for the roof edge system, when installed per manufacturer's instructions. Warranty will not exceed the warranty of the roof membrane on the south canopy of the Graduate School of Education.

PART 2 - PRODUCTS

2.1 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.

2.2 ROOF CURBS AND EQUIPMENT SUPPORTS

- A. General: Internally reinforced roof-mounted units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, straight sides, and integrally formed deck-mounting flange at perimeter bottom.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - a. The Pate Company.
 - b. Thycurb.
 - c. Or equal as approved by the Professional.
- B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- C. Supported Load Capacity: 500 pounds or five times the weight supported by curb, whichever is greater.
- D. Material: Zinc-coated (galvanized) steel sheet, 16 gauge thickness.
 - 1. Finish: Mill phosphatized.
- E. Construction:
 - 1. Profile: As indicated on drawings.
 - a. Stepped integral cant raised the thickness of roof insulation at sloped roof.
 - 2. Fabricate curbs and equipment supports to accept roof sheathing on outer surface after installation.
 - 3. Fabricate curbs and equipment supports to minimum height of 16 inches above finished roofing surface unless otherwise indicated.
 - 4. Top Surface: Level top of curbs and equipment supports, with roof slope accommodated by use of leveler frame.
 - 5. Sloping Roofs: Where roof slope exceeds 1:48, fabricate with perimeter height tapered to accommodate roof slope so that top surface of perimeter is level. Equip unit with water diverter or cricket on side that obstructs water flow.
 - 6. Insulation: Factory insulated with 3-inch-thick glass-fiber board insulation.
 - 7. Liner: Same material as curb or equipment support, of manufacturer's standard thickness and finish.

8. Nailer: Factory-installed wood nailer along top flange of curb or equipment support, continuous around perimeter.
 - a. Extend nailer beyond curb or equipment support to cover top edge of sheathing when installed.
9. Metal Counterflashing: As specified in Division 07 Section "Sheet Metal Flashing and Trim".

END OF SECTION 077200

SECTION 078413

THROUGH-PENETRATION FIRESTOP 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. Penetrations in fire-resistance-rated walls.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.
- B. Product test reports.
- C. Sample label for firestopping identification at penetrations in fire-resistance rated construction.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."
- B. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:
 - 1. Penetration firestopping assemblies shall comply with UL-tested assemblies in UL's "Fire Resistance Directory" under Product Category XHEZ.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Grace Construction Products. (Basis of Design)
 - 2. Nelson Firestop Products.
 - 3. 3M Fire Protection Products.
 - 4. Tremco, Inc.; Tremco Fire Protection Systems Group.
 - 5. Or equal as approved by the Professional.

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. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- C. 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.
- D. VOC Content: Penetration firestopping sealants and sealant primers 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.
- E. Low-Emitting Materials: Penetration firestopping sealants and sealant primers 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."
- F. VOC Emissions: Provide certificate of compliance with California Department of Public Health (CDPH) Standard Method v1.1-2010, using the applicable exposure scenario.
- G. VOC Content: Provide documentation of compliant VOC content per SCAQMD Rule 1168.
- H. 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.

PART 3 - EXECUTION

3.1 INSTALLATION

- 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. Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- C. 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.
- D. 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.
- E. Where firestopping protects penetrations by telecommunications cabling, use removeable pillow or bag firestopping products, to facilitate future cabling removal or addition.

3.2 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.

3.3 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system 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 through-penetration firestop systems are without damage or deterioration at time of Substantial

Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

END OF SECTION 078413

SECTION 079200

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. Latex joint sealants.
 - 3. Preformed foam joint sealants.
 - 4. Spray polyurethane foam sealants.
 - 5. Acoustical joint sealants.

1.3 PRECONSTRUCTION TESTING

- A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers four samples of materials that will contact or affect joint sealants. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.

1.4 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples: For each kind and color of joint sealant required.
- C. 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.
- B. Preconstruction compatibility and adhesion test reports.
- C. Preconstruction field-adhesion test reports.

- D. Warranties.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.

1.7 WARRANTY

- A. Special Installer's Warranty: Manufacturer's standard form in which 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 years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS, 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: Sealants and sealant primers used inside the weatherproofing system 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.
- C. VOC Emissions for Sealants: Provide certificate of compliance with California Department of Public Health (CDPH) Standard Method v1.1-2010, using the applicable exposure scenario.
- D. VOC Content for Sealants: Provide documentation of compliant VOC content per SCAQMD Rule 1168.
- E. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- F. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

A. Silicone, Neutral-curing silicone joint sealant; ASTM C 920.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - a. Dow Corning Corporation, 790.(Basis of Design)
 - b. GE corporation, SCS2700 SilPruf LM.
 - c. Tremco Incorporated, Spectrem 1.
 - d. Or equal as approved by the Professional.
2. Type: Single component (S).
3. Grade: nonsag (NS).
4. Class: 100/50.
5. Uses Related to Exposure: Nontraffic (NT).
6. Color: Three colors, as selected by Architect from Manufacturer's full range.
7. Locations: Exterior joints between different materials.

B. Single-Component Neutral-Curing Silicone Joint Sealant: ASTM C 920.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - a. Dow Corning Corporation, 795.(Basis of Design)
 - b. Pecora Corporation, 864.
 - c. Tremco Incorporated, Spectrem 2.
 - d. Or equal as approved by the Professional.
2. Type: Single component (S).
3. Grade: nonsag (NS).
4. Class: 50.
5. Uses Related to Exposure: Nontraffic (NT).
6. Stain-Test-Response Characteristics: Nonstaining to porous substrates per ASTM C1248.
7. Test sealant for compatibility and adhesion prior to installation.
8. Color: Three colors, as selected by Architect from Manufacturer's full range.
9. Locations: Exterior joints between same materials.

C. Single-Component Neutral-Curing Silicone Joint Sealant: ASTM C 920.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - a. Dow Corning Corporation, 758.(Basis of Design)
 - b. Pecora Corporation, 864.
 - c. GE corporation SCS2350.
 - d. Or equal as approved by the Professional.
2. Type: Single component (S).
3. Grade: nonsag (NS).
4. Class: 25.
5. Uses Related to Exposure: Nontraffic (NT).
6. Stain-Test-Response Characteristics: Nonstaining to porous substrates per ASTM C1248.
7. Test sealant for compatibility and adhesion prior to installation.
8. Color: Three colors, as selected by Architect from Manufacturer's full range.
9. Locations: Exterior sealing of weather/air barrier.

D. Mildew-Resistant, Neutral-Curing Silicone Joint Sealant: ASTM C 920.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - a. Dow Corning Corporation.(Basis of Design)
 - b. Pecora Corporation.
 - c. Tremco Incorporated.
 - d. Or equal as approved by the Professional.
2. Type: Single component (S).
3. Grade: nonsag (NS).
4. Class: 50.
5. Uses Related to Exposure: Nontraffic (NT).
6. Color: Three colors, as selected by Architect from Manufacturer's full range.
7. Locations: Joints between plumbing fixtures and floor, and toilet room counters and laboratory fixtures.

2.3 LATEX JOINT SEALANTS

A. Latex Joint Sealant: Paintable acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - a. Bostik, Inc.(Basis of Design)
 - b. Pecora Corporation.
 - c. Tremco Incorporated.
 - d. Or equal as approved by the Professional.
2. Color: White.
3. Locations:
 - a. Control and expansion joints on exposed interior surfaces.
 - b. Horizontal and Vertical joints on exposed surfaces of interior partitions.
 - c. Perimeter joints between interior wall surfaces and adjacent construction.

2.4 ACOUSTICAL JOINT SEALANTS

A. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - a. Pecora Corporation.(Basis of Design)
 - b. USG Corporation.
 - c. OSIP
 - d. Or equal as approved by the Professional.
2. Color: White
3. Locations: Between perimeter trim of acoustical panel assemblies and adjacent gypsum board partitions, perimeter of acoustic partition assemblies and where indicated on drawings.

2.5 JOINT SEALANT BACKING

- A. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin or Type B (bicellular material with a surface skin, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- B. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer.

2.6 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.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.
 - 1. Remove laitance and form-release agents from concrete.
 - 2. 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.
- 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.

3.2 INSTALLATION

- A. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- 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 according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
1. Remove excess sealant from surfaces adjacent to joints.
 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
- F. Acoustical Sealant Installation: Comply with ASTM C 919 and with manufacturer's written recommendations.
- G. 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.

END OF SECTION 079200

SECTION 081113
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:
 - 1. Standard and custom hollow metal doors and frames.
- B. Related Requirements:
 - 1. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.

1.3 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or 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, temperature-rise ratings, and finishes.
- B. Shop Drawings: Include the following:
 - 1. Elevations of each door and window type.
 - 2. Details of doors and windows, including vertical- and horizontal-edge details and metal thicknesses.
 - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 - 4. Locations of reinforcement and preparations for hardware.
 - 5. Details of each different wall opening condition.
 - 6. Details of anchorages, joints, field splices, and connections.
 - 7. Details of accessories.

8. Details of moldings, removable stops, and glazing.
9. Details of conduit and preparations for power, signal, and control systems.

- C. Schedule: Provide a schedule of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

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.
- 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. Available Manufacturers for Standard Hollow Metal Doors and Frames (HM): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 1. Amweld International LLC.(Basis of Design)
 2. Ceco Door, an Assa Abloy Company.
 3. Curries Company, an Assa Abloy Company.
 4. Hollow Metal, Inc.
 5. Republic Doors and Frames.
 6. Steelcraft, an Allegion brand.
 7. Or equal as approved by the Professional.
- B. Source Limitations: Obtain each type of hollow-metal work from single source from single manufacturer.

2.2 INTERIOR HOLLOW-METAL DOORS AND FRAMES (NON-RATED)

- A. Construct doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Extra-Heavy-Duty Doors and Frames: SDI A250.8, Level 3.

1. Physical Performance: Level A 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 16 gage, with minimum A60 coating.
 - d. Edge Construction: Model 2, Seamless.
 - 1) Provide closure channels at top and bottom edges of doors to create a six-sided box. Fully weld channels to door faces and internal framing and grind smooth to eliminate evidence of joints.
 - e. Core: Steel Stiffened.
 - 1) Vertically steel stiffeners and sound deadened with batt insulation. Fabricate hat shaped stiffeners from 20-gauge (0.026 inch) steel. Vertical interior webs spaced 6 inches maximum apart, welded to the inside of one face sheet and bonded to opposite face at 5 inches on center. Fill areas between stiffeners with fiberglass or mineral rock wool batt-type insulation.
3. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of 14 gage, with minimum A60 coating.
 - b. Construction: Full profile welded.
4. Exposed Finish: Prime.

2.3 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 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. 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, and as follows:
 1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

2.4 MATERIALS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Cold-Rolled Steel Sheet: ASTM A 1008, Commercial Steel (CS), Type B; suitable for exposed applications.
- C. Hot-Rolled Steel Sheet: ASTM A 1011, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- D. Metallic-Coated Steel Sheet: ASTM A 653, Commercial Steel (CS), Type B.

- E. Frame Anchors: ASTM A 879, Commercial Steel (CS), G90 coating designation; mill phosphatized.
 - 1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008 or ASTM A 1011, hot-dip galvanized according to ASTM A 153, Class B.
- F. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153.
- G. 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.
- H. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143.
- I. 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.
- J. Glazing: Comply with requirements in Section 088000 "Glazing."
- K. 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.

2.5 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. Vertical Edges for Single-Acting Doors: Provide beveled or square edges at manufacturer's discretion.
 - 2. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets.
 - 3. Bottom Edge Closures: Close bottom edges of doors with end closures or channels of same material as face sheets.
- C. Hollow-Metal Frames:
 - 1. Sidelite and Transom Bar 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. Face Width: 2 inches, unless otherwise noted.
 - 3. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 4. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
 - 5. 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.
 - 6. Jamb Anchors: Provide number and spacing of anchors as follows:

- a. Masonry Type: Locate anchors not more than 12 inches from top and bottom of frame. Space anchors not more than 32 inches o.c., to match coursing, and as follows:
 - 1) Four anchors per jamb up to 120 inches high.
 - 2) Four anchors per jamb plus one additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.
 - 7. 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 and louvers where indicated. Form corners of stops and moldings with butted 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 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.

2.6 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
 - 1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

2.7 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. 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 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 for doors, transoms, sidelites, borrowed lites, and other openings, 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. 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.
 - b. Install frames with removable stops located on secure side of opening.
 - c. Install door silencers in frames before grouting.
 - d. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - e. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
 - f. 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.
 - a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

3. 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. 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.
 6. 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. At Bottom of Door: 3/4 inch plus or minus 1/32 inch.
 - d. Between Door Face and Stop: 1/16 inch to 1/8 inch plus or minus 1/32 inch.
- D. Glazing: Comply with installation requirements in Section 088000 "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.
- D. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION 081113

SECTION 081416
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

1.3 RELATED DOCUMENTS

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

1.4 SUMMARY

- A. Section Includes:
1. Solid-core doors with wood-veneer faces.
 2. Factory finishing flush wood doors to receive natural finish.
 3. Factory machining for hardware.

1.5 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.
- 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. Requirements for veneer matching.
 6. Doors to be factory finished and finish requirements.
 7. Fire-protection ratings for fire-rated doors.
- C. Samples for Initial Selection: For factory-finished doors.
1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish. For each wood species and transparent finish, provide set of three Samples showing typical range of color and grain to be expected in finished Work.

2. Louver blade and frame sections, 6 inches long, for each material and finish specified.
3. Frames for light openings, 6 inches long, for each material, type, and finish required.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body and 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 shall also include installation and finishing that may be required due to repair or replacement of defective doors.
 3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 1. Eggers Industries.(Basis of Design)
 2. Mohawk Flush Doors, Inc.
 3. VT Industries, Inc.
 4. Or equal as approved by the Professional.

2.2 FLUSH WOOD DOORS, GENERAL

- A. Quality Standard: In addition to requirements specified, comply with WDMA I.S.1-A, "Architectural Wood Flush Doors."
- B. EPD for Wall Panels: Provide an industry-wide EPD in accordance with ISO 14025 and has at least a cradle to gate scope.
- C. Certified Wood: Flush wood doors shall be certified as "FSC Pure" or "FSC Mixed Credit" according to FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship," and to FSC STD-40-004, "FSC Standard for Chain of Custody Certification."
- D. Low-Emitting Materials: Fabricate doors with adhesives and composite wood products that do not contain urea formaldehyde.
- E. WDMA I.S.1-A Performance Grade: Heavy Duty.
- F. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control, based on testing according to UL 1784.
- G. 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.

2.3 VENEER-FACED DOORS FOR TRANSPARENT (NATURAL) FINISH

- A. Interior Solid-Core Doors:
 - 1. Grade: Custom (Grade A faces).
 - 2. Species: Select white maple.
 - 3. Cut: Quarter 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. Room Match: Provide door faces of compatible color and grain within each separate room or area of building.
 - 8. Core: Glued wood stave.
 - 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.
 - 10. WDMA I.S.1-A Performance Grade: Heavy Duty.

2.4 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.

2.5 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
- 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.
 - 1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
- C. Openings: Factory cut and trim openings through doors.
 - 1. Light Openings: Trim openings with moldings of material and profile indicated.
 - 2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."

2.6 SHOP PRIMING

- A. Doors for Opaque Finish: Shop prime faces, all four edges, edges of cutouts, and mortises with one coat of wood primer specified in Section 099123 "Interior Painting."

2.7 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 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-6 catalyzed polyurethane.
 - 3. Staining: As selected by Architect from manufacturer's full range.
 - 4. 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 087100 "Door Hardware."
- B. Installation Instructions: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
 - 1. 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 1/8 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.
 - b. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.
 - 2. 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 081416

SECTION 083113

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 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 access doors and frames for walls and ceilings.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, fire ratings, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Product Schedule: For access doors and frames.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection and temperature-rise limit ratings indicated, according to NFPA 252 or UL 10B.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Acudor, Nelson Industrial Inc.(Basis of Design)
 - 2. Karp Associates, Inc.
 - 3. Nystrom Building Products.
 - 4. Or equal as approved by Professional

- B. EPD for Doors and Frames: Provide a product-specific Type III EPD in accordance with ISO 14025 and has at least a cradle to gate scope.

2.3 ACCESS DOORS AND FRAMES

- A. Flush Access Doors with Exposed Flanges **(AD-1)**
 - 1. Description: Face of door flush with frame, with exposed flange and concealed hinge.
 - 2. Optional Features:
 - 3. Locations: Wall
 - 4. Door Size: 18 inches square, or as shown on drawings
 - 5. Uncoated Steel Sheet for Door: 18 gauge, factory primed.
 - 6. Frame Material: Same material, thickness, and finish as door
 - 7. Latch and Lock: Cam latch, key operated
 - 8. Location: Tiled and exposed CMU Walls
- B. Flush Wall Access Doors with Concealed Flanges: **(AD-2)**
 - 1. Description: Face of door flush with frame; with concealed flange for gypsum board installation and concealed hinge.
 - 2. Locations: Wall.
 - 3. Door Size: 18 inches square, or as shown on drawings.
 - 4. Uncoated Steel Sheet for Door: 18 gauge, factory primed.
 - 5. Frame Material: Same material and thickness as door.
 - 6. Latch and Lock: Cam latch, operated by lock cylinder.
 - 7. Location: GWB Walls
- C. Flush Ceiling Access Doors with Concealed Flanges: **(AD-3)**
 - 1. Description: Face of door flush with frame; with concealed flange for gypsum board installation and concealed hinge.
 - 2. Locations: Ceiling.
 - 3. Door Size: 18 inches square, or as shown on drawings.
 - 4. Uncoated Steel Sheet for Door: 18 gauge, factory primed.
 - 5. Frame Material: Same material and thickness as door.
 - 6. Latch and Lock: Cam latch, screwdriver-operated.
 - 7. Location: GWB Ceilings

2.4 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36.
- B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879, with cold-rolled steel sheet substrate complying with ASTM A 1008, Commercial Steel (CS), exposed.
- C. Metallic-Coated Steel Sheet: ASTM A 653, Commercial Steel (CS), Type B; with minimum G90 metallic coating.
- D. Frame Anchors: Same material as door face.
- E. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153 or ASTM F 2329.
- F. Lock cylinder: As specified in Division 08 Section "Door Hardware":
 - 1. Manufacturer: Schlage Commercial Lock Division.

2. Keyway: Primus XP.
 3. 7-pin full-size cylinder.
- G. Recycled Content of Metal: Provide documentation indicating postconsumer recycled content plus one-half of preconsumer recycled content.
- H. Regional Material for Metal: Provide documentation indicating distance to project site, cost for each regional material and fraction by weight that is considered regional.

2.5 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 mounting holes, 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 panels securely attached to perimeter of frames.
- D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling. Provide access sleeves for each latch operator and install in holes cut through finish.
- E. Latch and Lock Hardware:
1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
 2. Keys: Furnish two keys per lock and key all locks alike.

2.6 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. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

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. Comply with manufacturer's written instructions for installing access doors and frames.

3.3 ADJUSTING

- A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION 083113

SECTION 083323
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 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. Exterior insulated overhead coiling service doors (electrically operated).
- B. Related Requirements:
 - 1. Section 055000 "Metal Fabrications" for miscellaneous steel supports.
 - 2. Section 087100 "Door Hardware" for lock cylinders.

1.4 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 details of provisions for assembly expansion and contraction and for excluding and draining moisture to the exterior.
 - 5. Show locations of controls, locking devices, and other accessories.

6. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.

1. Include similar samples of accessories involving color selection.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer. Provide confirmation that installer is approved by Manufacturer of Overhead Coiling Door and has successfully installed similar doors. Provide a list of completed installations including Owner name and phone number or e-mail address.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For overhead coiling doors 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 for both installation and maintenance of units required for this Project.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of doors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS, GENERAL

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

1. Cornell Cookson (Basis of Design).
2. McKeon
3. Overhead
4. Or equal as approved by the Professional.

B. Basis-of-Design Product:

1. Manufacturer: Cornell Cookson
2. Product: Thermiser

C. Source Limitations: Obtain overhead coiling doors and all components associated with door operations from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Capable of withstanding the design wind loads.
 - 1. Design Wind Load: Uniform pressure (velocity pressure) of 20 lbf/sq. ft., acting inward and outward.
 - 2. Testing: According to ASTM E 330.
 - 3. Deflection Limits: Design overhead coiling doors to withstand design wind load without evidencing permanent deformation or disengagement of door components.
 - 4. Operability under Wind Load: Design overhead coiling doors to remain operable under uniform pressure (velocity pressure) of 20 lbf/sq. ft. wind load, acting inward and outward.

2.3 DOOR ASSEMBLY

- A. Insulated Service Door: Overhead coiling door formed with curtain of interlocking metal slats.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide the following manufacturer and product, or equal as approved by the Professional:
 - 1. Manufacturer: CornellCookson, Inc. 800-233-8366.
 - a. Product: Thermiser Max Rolling Door, Model ESD30.
 - 2. McKeon Rolling Steel Door Company, Inc.
 - 3. Overhead Door Corporation.
 - 4. Or equal as approved by the Professional.
- C. Operation Cycles: Door components and operators capable of operating for not less than 50,000. 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.
- D. Air Infiltration: Maximum rate of 0.3 cfm/sq. ft. at 15 and 25 mph when tested according to ASTM E 283.
 - 1. Comply with ASHRAE (American Society of Heating, Refrigeration, and Air-Conditioning Engineers) Standard 90.1 2022 and IECC (International Energy Conservation Code) 2021 requirements.
- E. Curtain R-Value: 8.0 deg F x h x sq. ft./Btu.
- F. Door Curtain Material: Galvanized steel.
- G. Door Curtain Slats: Flat profile slats of 3-inch center-to-center height.
 - 1. Insulated-Slat Interior Facing: Metal.
 - 2. Gasket: Manufacturer's standard gaskets to prevent metal-to-metal contact with guides, installed on every other slat, minimum.
- H. Bottom Bar: Two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch thick; fabricated from aluminum extrusions.
 - 1. Finish: Powder coat to match slats.
 - 2. Provide Air Infiltration Certification Label affixed to bottom bar.

- I. Curtain Jamb Guides: Galvanized steel with exposed finish matching curtain slats.
 - 1. Provide thermal break at exterior doors. Minimum 3/16-inch structural steel angles. Provide windlock bars of same material when windlocks are required to meet specified wind load. Top of inner and outer guide angles to be flared outwards to form bellmouth for smooth entry of curtain into guides. Provide removable guide stoppers to prevent over travel of curtain and bottom bar.
 - 2. Top 16 1/2" of coil side guide angles to be removable for ease of curtain installation and as needed for future curtain service.
- J. Hood: Galvanized steel.
 - 1. Shape: Round.
 - 2. Mounting: Face of wall.
- K. Locking Devices: Equip door with locking device assembly.
 - 1. Locking Device Assembly: Masterkeyable cylinder operable from coil sides of bottom bar. At electrical doors provide motor mounted interlock sensor, guide mounted interlocks are not acceptable.
 - a. Best CORMAX 7-Pin.
- L. Electric Door Operator:
 - 1. Usage Classification: Medium duty, up to 20 cycles per hour and up to 50 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: Exterior, wet, and humid.
 - 5. Emergency Manual Operation: Push-up type.
 - 6. Obstruction-Detection Device: Continuously monitored, wireless sensing/weather edge seal extending full width of door bottom bar.
 - a. Sensor Edge Bulb Color: Black.
 - 7. Control Station(s): Where indicated on Drawings.
- M. Curtain Accessories: Equip door with weatherseals and push/pull handles.
- N. Door Finish:
 - 1. Powder-Coated Finish: To Match Architect's Sample
 - 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, with G90 zinc coating; nominal sheet thickness (coated) of 20 gauge; 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.
 - a. Insulation thickness: 7/8-inch, minimum.
 - 3. Metal Interior Curtain-Slat Facing: Match exterior surface of curtain slats.
- 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, and a continuous bar for holding windlocks.

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-thick, hot-dip galvanized steel sheet with G90 zinc coating, complying with ASTM A 653.

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 087100 "Door Hardware".
 - 2. Keys: Three for each cylinder.
- B. 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, 1/8-inch-thick seals of flexible rubber or neoprene.
- B. Push/Pull Handles: Equip door with lifting handles on each side of door, finished to match door, for use in emergency situations.

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 Shaft or Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, seamless or welded 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.
- 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 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. Door Operator Location(s):

1. Front-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on coil side of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Front clearance is required for this type of mounting.
- D. Motors: Reversible-type motor with controller (disconnect switch) for motor exposure indicated.
1. Electrical Characteristics:
 - a. Phase: Single phase.
 - b. Volts: 120 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.
- E. 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.
- F. Obstruction Detection Devices: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of door opening. Activation of device immediately stops and reverses downward door travel.
1. Momentary Contact to Close: Fail-safe, UL 325-2010 Compliant Entrapment Protection for Motor Operation.
 - a. Continuously monitored, wireless sensing/weather edge seal extending full width of door bottom bar. Contact before door fully closes shall cause door to immediately stop downward travel and reverse direction to the fully opened position.
- G. 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." Provide (2) per door.
1. Interior-Mounted Units: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
 2. Exterior-Mounted Units: Full-guarded, standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosure, key operated.
- H. 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.
- I. 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.

- J. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

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. 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. Color selected by the Professional from manufacturer's standard color range.

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.
 1. Adjust exterior doors and components to be weather-resistant.
- B. Lubricate bearings and sliding parts as recommended by manufacturer.
- C. Adjust seals to provide tight fit around entire perimeter.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Client Agency's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION 083323

SECTION 084113

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 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. Interior Non-Thermal storefront framing, including door frame units, noted Interior Glass Wall (IGW) on drawings.
 - 2. Exterior Thermally-Improved storefront windows, noted A-F on drawings.
 - 3. Exterior Thermally-Improved storefront framing including door frame units,
- B. Related Sections:
 - 1. Section 054000 "Cold Formed Metal Framing" for header support.
 - 2. Section 087100 "Door Hardware".

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. 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. Identify locations and sizes of all loads imposed on the building and adjacent construction.
- C. 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. Include full-size isometric details of each vertical-to-horizontal intersection of aluminum-framed entrances and storefronts, showing the following:

- a. Joinery, including concealed welds.
 - b. Anchorage.
 - c. Interface with adjacent materials, including weather resistant barrier.
 - d. Glazing.
- D. Samples for Verification: For each finish selected during initial review. Provide each finish on full-size aluminum extrusion specified for project, minimum 12 inches long.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For aluminum-framed entrances and storefronts 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.
- 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.

1.7 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. Deterioration of metals, metal finishes, and other materials beyond normal wear.
 - 2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," 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. Glass breakage.
 - b. Noise or vibration created by structural movements.
 - c. Loosening or weakening of fasteners, attachments, and other components.
- C. Recycled Content: Provide documentation indicating postconsumer recycled content plus one-half of preconsumer recycled content.
- D. Structural Loads:
1. Wind Loads: As indicated on Drawings.
 2. Other Design Loads: As indicated on Drawings.
 - a) Provide top of Interior Glass Walls load reactions to cold formed metal framing contractor for design of CFMF header loads.
- E. Deflection of Framing Members: At design wind pressure, as follows:
1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches 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.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
1. Basis of Design, Kawneer.
 - a. Series 451 Non-Thermal (Interior)
 - b. Series 451 Thermally Improved (Exterior)
 2. YKK AP.
 3. Oldcastle Building Envelope
 4. Or equal as approved by the Professional
- B. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing 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: Nonthermal.
 - a. Framing Depth: 4-1/2" inches, minimum.
 - b. Face Width: 2 inches, minimum.
 - c. Sill: 4" high.
 - d. Aluminum Thickness: 0.125 inches, minimum.
 - e. Glazing System: Retained mechanically with gaskets on four sides.
 - f. Glazing Plane: Center.
 - g. Finish: High-performance organic finish.

- h. Fabrication Method: Field-fabricated shear block stick system.
 - i. Prepare openings for flush wood door installation, reinforce mullions adjacent to doors.
- 2. Construction: Thermally improved.
 - a. Framing Depth: 6-1/2" inches, minimum.
 - b. Face Width: 2 inches, minimum.
 - c. Sill: 2" high.
 - d. Aluminum Thickness: 0.125 inches, minimum.
 - e. Glazing System: Retained mechanically with gaskets on four sides.
 - f. Glazing Plane: Inside.
 - g. Finish: High-performance organic finish.
 - h. Fabrication Method: Field-fabricated shear block 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.

2.4 GLAZING

- A. Glazing: Comply with Section 088000 "Glazing."
- B. Glazing Sealants: As recommended by manufacturer.
 - 1. VOC Emissions for Sealants: Provide certificate of compliance with California Department of Public Health (CDPH) Standard Method v1.1-2010, using the applicable exposure scenario.
 - 2. VOC Content for Sealants: Provide documentation of compliant VOC content per SCAQMD Rule 1168.

2.5 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 vibration.
 - 2. Reinforce members as required to receive fastener threads.
 - 3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.
- 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. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.
- D. Joint Sealants: For installation at perimeter of framed systems, as specified in Division 07 Section "Joint Sealants."

2.6 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. 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 isolation of glazing from framing members.
 - 4. Accommodations for mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 5. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- C. Storefront Framing: Fabricate components for assembly using screw-spline system.
- D. Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
 - 1. 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.
- E. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.7 ALUMINUM FINISHES

- A. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm

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. 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.
- C. Install components plumb and true in alignment with established lines and grades.
- D. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.
- E. Install glazing as specified in Section 088000 "Glazing."

3.3 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.
 2. Level: 1/8 inch in 20 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.

END OF SECTION 084113

SECTION 086200

UNIT SKYLIGHTS

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. Unit skylights.

- B. Related Requirements:

- 1. Section 061053- Miscellaneous Rough Carpentry
 - 2. Section 076200 – Sheet Metal Flashing and Trim
 - 3. Section 084513 "Structured-Polycarbonate-Panel Assemblies" for metal-framed skylights glazed with translucent insulating panels.

1.4 ACTION SUBMITTALS

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

- 1. Include product dimensions, construction details, material descriptions, dimensions and profiles of components, and finishes.

- B. Shop Drawings:

- 1. Include plans, elevations, sections, mounting, and attachment details and methods of structural support.
 - 2. Include diagrams for power, signal, and control wiring.

- C. Samples for Verification: For each product, as follows:

1. Glazing: In manufacturer's standard size and of same thickness indicated for the final Work.
2. Finishes: For each type and color of factory-applied exposed finish required, in manufacturer's standard size.

D. Product Schedule: For each type of product specified

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each type and size of product, for tests performed by a qualified testing agency on specimens equal to or greater than sizes required for Project.
- B. Product Data Sheet
- C. Field quality-control reports.
- D. Sample Warranty: For special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For products and accessories to include in maintenance manuals.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of products that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

- a. Failure to meet performance requirements.
- b. Water leakage not controlled by drainage features.
- c. Deterioration of materials and finishes beyond normal weathering.
- d. Yellowing of acrylic glazing.
- e. Breakage of polycarbonate glazing.
- f. Deterioration of insulating-glass units including failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating-glass units contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

2. Warranty Period:

- a. Products and Accessories: Five years from date of Substantial Completion
- b. Insulating-Glass Units: 20 years from date of Substantial Completion.

- B. Special Aluminum Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of finish deterioration within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

- a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
 - c. Cracking, peeling, checking, or chipping.
2. Warranty Period: 5 years from date of shipment.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Performance Standard: Comply with AAMA/WDMA/CSA 101/1.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
 1. Minimum Performance Grade: PG 70
 2. Label Requirements: Label each product with names of manufacturer and labeling agency and AAMA/WDMA/CSA 101/1.S.2/A440 product designation, performance grade, and test specimen size equal to or greater than the size of the product.
 3. Certification Requirements: Provide AAMA certified products, with label attached to each.
- B. Thermal Transmittance: NFRC 100 maximum U-factor of 0.46 Btu/sq. ft. x h x deg F (2.61 W/sq. m x K) [0.48 Btu/sq. ft. x h x deg F (2.73 W/sq. m x K)]
- C. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum SHGC of 0.35
- D. Visible Light Transmission shall be 40 %
- E. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone 2 for basic protection.
 1. Large-Missile Test: For glazing located within 30 feet (9.1 m)] of grade.
 2. Small-Missile Test: For glazing located between 30 feet (9.1 m) and 60 feet (18.3 m)] < above grade.
- F. Plastic Glazing:
 1. Self-Ignition Temperature: 650 deg F (343 deg C) or more for plastic sheets in thickness indicated when tested in accordance with ASTM D1929.
 2. Smoke-Production Characteristics: Smoke-developed index of 75 or less when tested in accordance with ASTM E84, and smoke density of 75 or less when tested in accordance with ASTM D2843.
 3. Combustibility Characteristics: Tested in accordance with ASTM D635 and classified for burning rate of nominal thickness of 0.060 inch (1.5 mm) or thickness of plastic glazing indicated for use as follows:
 - a. Class CC1: Burning rate of 1 inch (25 mm) per minute or less.
 - b. Class CC2: Burning rate of 2-1/2 inches (64 mm) per minute or less.
- G. Provide flat cellular polycarbonate panel fabricated from an approved cellular polycarbonate glazing (light transmitting) material identical to that tested with a CC1 fire rating classification per ASTM D-635 and filled with Lumira™ aerogel insulation in the thickness (10mm) intended for use.

- H. Self-Ignition Temperature: 1110° F (599 deg. C) or greater when tested per ASTM 1929 on multi-wall cellular panel filled with Lumira™ aerogel insulation in the thickness (10mm) intended for use.
- I. Exterior Fire-Test Exposure: Provide products identical to those of assemblies tested for Class B fire resistance in accordance with ASTM E108 or UL 790 by Underwriters Laboratories or another testing and inspecting agency acceptable to authorities having jurisdiction.
- J. Fall-Protection Performance: Installed assemblies are capable of safely supporting the greater of 400 lbs (181.4 kg)

2.2 UNIT SKYLIGHTS <US-1>

- A. Factory-Assembled Skylight: Unit that includes glazing, extruded-aluminum glazing retainers, gaskets, and inner frame.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. VELUX Wasco – CLD2 (Basis-of-Design)
 - b. American Skylights
 - c. Kingspan
 - d. Or equal as approved by the Professional
- C. Product Type: AAMA/WDMA/CSA 101/1.S.2/A440 Single Dome Skylight over 10 mm aerogel filled panel
 - 1. Provide fixed (nonoperable)
 - 2. Single-Glazing Profile:
 - a. Thicknesses of Each Glazing Layer: Not less than thicknesses required to meet specified requirements
- D. Polycarbonate Interior Laylite Sheet: 10mm multi-wall flat cellular polycarbonate panel filled with Lumira™ aerogel insulating material.
- E. Glazing Gaskets: Structural glazing tape to form adhesive bond between PVC curb and inner laylite, between inner laylite and inner dome, and between inner dome and outer dome. Butyl tape between outer dome and extruded aluminum retainer. Gaskets form an air and water impenetrable barrier between adjacent surfaces.
- F. Integral Curb: Fabricate from double skin of 1100-H14 sheet aluminum, insulated with 1-1/2", R5.8, EPS insulation. Provide thermal break at top and bottom.
 - 1. Provide .025-inch minimum thickness outer skin, mill finish. Outer skin to be .032 inch when length exceed nominal 48"
 - 2. Provide .032-inch minimum thickness inner skin, prefinished white.
 - 3. Curb assembly to have a minimum U-value of 0.17.

- G. Condensation Control: Fabricate unit skylights with integral internal gutters and nonclogging weeps to collect and drain condensation to the exterior.
- H. Thermal Break: Fabricate unit skylights with thermal break separating exterior and interior metal framing.
- I. Accessories:
 - 1. Clear Anodic Finish: AAMA 611, [AA-M12C22A41, Class I, 0.018 mm] [AA-M12C22A31, Class II, 0.010 mm] or thicker.

2.3 ACCESSORY MATERIALS

- A. Fasteners: Same metal as metal being fastened, nonmagnetic stainless steel, or other noncorrosive metal that is compatible with the materials being fastened and as recommended in writing by manufacturer. Finish exposed fasteners to match material being fastened.
 - 1. Where removal of exterior exposed fasteners might allow access to building, provide nonremovable fastener heads.
- B. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine openings, substrates, structural support, anchorage, 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. Coordinate installation of products and accessories with installation of substrates, vapor retarders, roof insulation, roofing membrane, and flashing as required to ensure that each element of the Work performs properly and that combined elements are waterproof and weathertight.
- B. Install products and accessories to comply with recommendations in AAMA 1607 and with manufacturer's written installation instructions.
- C. Install products true to line and without distortion.
- D. Anchor products securely to supporting substrates.
- E. Where metal surfaces of products will contact other metal or corrosive substrates, such as preservative-treated wood, apply bituminous coating on concealed metal surfaces or provide other approved permanent separation recommended in writing by manufacturer.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. After completion of installation and nominal curing of sealant and glazing compounds, but before installation of interior finishes, test for water leaks in accordance with AAMA 501.2.
- C. Perform test for total area of each installed product.
- D. Work will be considered defective if it does not pass tests and inspections.
- E. Additional testing and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- F. Prepare test and inspection reports.

3.4 CLEANING AND ADJUSTING

- A. Clean exposed product surfaces in accordance with manufacturer's written instructions. Touch up damaged metal coatings and finishes.
- B. Remove excess sealants, glazing materials, dirt, and other substances.
- C. Remove and replace glazing that has been broken, chipped, cracked, abraded, or damaged during construction period.
- D. Protect product surfaces from contact with contaminating substances resulting from construction operations.

END OF SECTION 086200

SECTION 087100
DOOR HARDWARE

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. Mechanical door hardware for swinging doors and coiling doors.
- B. Products furnished, but not installed, under this Section include the products listed below. Coordinating and scheduling the purchase and delivery of these products remain requirements of this Section.
 - 1. Permanent lock cores to be installed by the Client Agency.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Door Hardware Schedule: Prepared by or under the supervision of Installer, detailing fabrication and assembly of door hardware, as well as installation procedures and diagrams. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - 1. Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.
 - 2. Content: Include the following information:
 - a. Identification number, location, hand, size, and material of each door and frame.
 - b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
 - c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Professional, and Client Agency about door hardware and keying.

- B. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
- C. Accessibility Requirements: For door hardware on doors in an accessible route, comply with ICC/ANSI A117.1.
 - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
 - 2. Comply with the following maximum opening-force requirements:
 - 3. Adjust door closer sweep periods so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver keys and permanent cores to the Client Agency by registered mail or overnight package service.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Three years from date of Substantial Completion, unless otherwise indicated.
 - a. Exit Devices: Five years from date of Substantial Completion.
 - b. Manual Closers: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. Provide door hardware for each door as scheduled in Part 3 "Door Hardware Schedule" Article to comply with requirements in this Section.
 - 1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products.
- B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Schedule" Article. Products are identified by using door hardware designations, as follows:
 - 1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in Part 3 "Door Hardware Schedule" Article.
- C. All locks shall be furnished with removable core cylinders, and shall be a factory recorded continuation or extension of an existing keying system previously furnished for this institution.
 - 1. New building: A new keying schedule shall be started in accordance with Paragraph E. The keying records for both new buildings and existing buildings belong to the

Commonwealth of Pennsylvania and on request, in writing, will be furnished in accordance with Paragraph B.

2. Existing system where small quantities of cores are required: The Institution shall specify the keyway required and uncombined cores and key blanks needed. The combining will be done by the Institution.
 3. Existing system where large quantities of cores are required: The Institution shall furnish the keying records to the Director of the Key Record Department of the Lock Company, so that cores can be combined in the factory and in accordance with paragraph B.
- D. The Key Coding records shall be sent by Registered Mail to the Institution's Facility Maintenance Manager at the completion of the Project. These records shall go directly from the Manufacturer to the Institution and shall not pass through the hands of the Hardware Distributor.
- E. Cylinders shall be furnished complete with collars, construction cores, 7-pin interchangeable cores, and two keys per cylinder. Cylinders shall be of correct type and length, fitted with correct cam or bar for operation of lock, and furnished with back plates and screws where required.
- F. Construction cores shall be supplied to the General Contractor during the period of construction. These construction cores shall be returned to the Manufacturer after the permanent master keyed cores are installed.
- G. Cores are to be Grand Master Keyed, Master Keyed, Keyed alike in Groups, and/or Keyed individually, as approved by the Institution. A Keying Schedule showing each door location, Manufacturer's lock number, Manufacturer's cylinder type number, finish, length, cam or bar type, and keying detail, shall be prepared by the Cylinder Manufacturer's Representative for the Hardware Supplier, and submitted to the Institution for approval. The Cylinder Manufacturer's Representative shall provide technical assistance and information to the Institution in establishing the keying system. Master keyed cores shall be installed by the General Contractor.
- H. Furnish six (6) Master Keys for each group. Furnish six (6) Grand Master Keys and one (1) Control Key, if a new Grand Master Key System is established. The above keys shall be included with the shipment of permanent cores.

2.2 HANGING DEVICES

- A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Hager Companies (Basis of Design).
 - 1) Product: BB1279 Series.
 - b. Stanley Commercial Hardware; Div. of The Stanley Works.
 - 1) Product: FBB179 Series.
 - c. Best
 - d. Or equal as approved by the Professional
 2. Hinge Mounting: Full mortise.
 3. Hinge Size: 4-1/2 inches by 4-1/2 inches.
 4. Square corners.
 5. Provide non-removable pins when hinge barrel is located on non-secure side of door.
- B. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 certified continuous geared hinge with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a

minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Bommer Industries (BO).(Basis of Design)
 - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).
 - c. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
 - d. Or equal as approved by the Professional

2.3 MECHANICAL LOCKS AND LATCHES

- A. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.
 1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
- B. Manufacturer: Provide products by Best Access Systems, an Assa Abloy Company.
 1. Locksets shall be compatible with the Institution's existing standard Best interchangeable cores.
 2. **The above item has been approved by the Department as a proprietary item. No other item will be accepted. Section 9.6 and 9.7 of the General Conditions to the Construction Contract does not apply to the above item.**
- C. Bored Locks: BHMA A156.2; Grade 1. 4000 Series.
 1. Product: 9K Series.
- D. Lever Handle: Design as selected by the Professional from full range, of available styles.
- E. Dummy Trim: Match lever design selected for project.

2.4 EXIT DEVICES AND AUXILIARY ITEMS

- A. Exit Devices and Auxiliary Items: BHMA A156.3.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Allegion
 - b. Corbin Russwin
 - c. Von Duprin; an Ingersoll-Rand company.(Basis of Design)
 - d. Product: 98 Series.
 - 1) Rim exit device.
 - 2) Smooth case.
 - 3) Cylinder dogging.
 - 4) Vertical rod where indicated for inactive leaf operation.
 - 5) Lever trim on secure side of door as selected by the Professional from full range of available styles.

- e. Or equal as approved by the Professional

2.5 LOCK CYLINDERS

- A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.
 - 1. Manufacturer: Best Access Systems (AGS Standard).
 - 2. Cylinders shall be compatible with the Institution's existing standard Best interchangeable cores.
- B. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 5 construction master keys.
- C. **The above item has been approved by the Department as a proprietary item. No other item will be accepted. Section 9.6 and 9.7 of the General Conditions to the Construction Contract does not apply to the above item.**

2.6 OPERATING TRIM

- A. Operating Trim: BHMA A156.6; stainless steel, unless otherwise indicated.
 - 1. 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:
 - a. IVES Hardware; an Ingersoll-Rand company. (Basis of Design)
 - 1) Product: Flush Pull 962.
 - b. Rockwood Manufacturing Company.
 - 1) Product: RM94.
 - c. Best
 - d. Or equal as approved by the Professional.

2.7 SURFACE CLOSERS

- A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following, or equal as approved by the Professional:
 - a. Von Duprin
 - b. TruDoor
 - c. LCN Closers; an Ingersoll-Rand company.(Basis of Design)
 - Series: 4040XP Heavy-duty Closer (Basis of Design).
 - Provide parallel arm when closer is mounted on push side of door.
 - Provide plated cover for closer mechanism.
 - d. Or equal as approved by the Professional

2.8 MECHANICAL STOPS AND HOLDERS

- A. Wall-Mounted Stops: BHMA A156.16; polished wrought stainless steel base metal.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. IVES Hardware; an Ingersoll-Rand company (Basis of Design).
 - 1) Product: 407-1/2 Wall Door Stop.
 - b. Rockwood Manufacturing Company.
 - 1) Product: 409/410/411 Series.
 - c. McMaster Carr
 - d. Or equal as approved by the Professional

2.9 OVERHEAD STOPS AND HOLDERS

- A. Overhead Stops and Holders: BHMA A156.8.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal as approved by the Professional:
 - a. Glynn-Johnson; an Ingersoll-Rand company (Basis of Design).
 - 1) Products:
 - a) Concealed: 100 Series.
 - b. Rockwood Manufacturing Company.
 - 1) Products:
 - a) Concealed: Series 11000.
 - c. Ives
 - d. Or as approved by the Professional.

2.10 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
- B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
 - 1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
 - 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following :
 - a. National Guard Products.(Basis of Design)
 - 1) Product: 5050 Silicone bulb.
 - b. Pemko Manufacturing Co.; an ASSA ABLOY Group company.
 - 1) Product: S88 Silicone gasketing.
 - c. Reese Enterprises, Inc.
 - 1) Product: 638 Series.
 - d. Or equal as approved by the Professional
- C. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

- D. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- E. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following :
 - 1. National Guard Products (NG).
 - 2. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
 - 3. Reese Enterprises, Inc. (RE).
 - 4. Or equal as approved by the Professional.

2.11 THRESHOLDS

- A. Thresholds: Multi-part assembly consisting of threshold rest(s) and grooved plate with thermal break; fabricated as indicated on drawings.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. National Guard Products.
 - b. Pemko Manufacturing Co.; an ASSA ABLOY Group company (Basis of Design).
 - 1) Type 1:
 - a) Floor Plate/Safety Tread 200.
 - b) Floor Plate/Safety Tread 19325 (6-1/2 inches wide). Provide thermal break within grooved plate.
 - c. Reese Enterprises, Inc.
 - d. Zero International.
 - e. Or equal as approved by the Professional.
 - 2. Total Assembly Width: Full width of opening indicated.
 - 3. Depth: Match wall depth.
 - 4. Cope around frame jamb.

2.12 METAL PROTECTIVE TRIM UNITS

- A. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch-thick stainless steel; with manufacturer's standard machine or self-tapping screw fasteners.
 - 1. Height: 6 inches, unless otherwise noted.
 - 2. Width:
 - a. Two inches less than door width on stop side of door.
 - b. One inch less than door width on non-stop side of door.
 - 3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following: :
 - a. IVES Hardware; an Ingersoll-Rand company.
 - b. Rockwood Manufacturing Company.
 - c. Trimco Architectural Hardware.
 - d. Or equal as approved by the Professional

2.13 AUXILIARY DOOR HARDWARE

- A. Hat and Coat Hook Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

1. Manufacturer: Hafele America Co.
Product: 842.02.906 (Basis of Design).
2. McMaster-Carr
3. Gamco
4. Or equal as approved by the Professional.

2.14 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.
 1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.

2.15 FINISHES

- A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Steel Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.
- B. Mounting Heights: 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.
- C. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

- D. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent.
- E. Lock Cylinders: Install construction cores to secure building and areas during construction period.
1. Furnish permanent cores to the Client Agency for keying and installation.
- F. Perimeter Gasketing: Apply to head and jambs, forming seal between door and frame.
1. At double doors, apply to astragal.
- G. 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.

DOOR HARDWARE SCHEDULE

Door Hardware Set No. 1

Location: Single Exterior Exit Door (Doors 102-2, 103-2, 121-1, 122-1)

Qty.	Description	Item	Finish
1	Hanging Devices	Geared Continuous Hinge	626
1	Exit Device	Rim Exit Device with Lever	630
2	Securing Device	Key Cylinder	626
1	Protective Trim Units	Kickplate	630
1	Closer	Surface Closer with Stop and Hold Open	626
1 set	Miscellaneous	Weatherstripping	
1	Miscellaneous	Door Sweep	
1	Miscellaneous	Threshold	Aluminum

Door Hardware Set No. 2

Location: Single Interior Door Office Function (Doors 104-1, 112-1, 113-1, 114-1, 115-1)

Qty.	Description	Item	Finish
3	Hanging Devices	Hinges	626
1	Securing Device	Cylindrical Lockset Office Function	626
1	Securing Device	Key Cylinder	
2	Protective Trim Units	Kick plate	630
1	Miscellaneous	Wall Stop	
2	Accessories	Hat and Coat Hook	
	Miscellaneous	Silencers	

Door Hardware Set No. 3

Location: Single Interior Door -Privacy Function (Door 116-1)

Qty.	Description	Item	Finish
3	Hanging Devices	Hinges	626
1	Securing Device	Cylindrical Lockset Privacy Function	626
1	Securing Device	Key Cylinder	
2	Protective Trim Units	Kick plate	630

1	Closer	Surface Closer with Hold open	626
1	Miscellaneous	Wall Stop	
2	Accessories	Hat and Coat Hook	
	Miscellaneous	Silencers	

Door Hardware Set No. 4

Location: Single Interior Door in Restroom (Doors 106-1, 117A-1, 117-1, 118A-1, 118-1)

Qty.	Description	Item	Finish
3	Hanging Devices	Hinges	626
1	Securing Device	Cylindrical Lockset Passage Function	626
1	Securing Device	Key Cylinder	
2	Protective Trim Units	Kick plate	630
1	Closer	Surface Closer with Hold open	626
1	Miscellaneous	Wall Stop	
2	Accessories	Hat and Coat Hook	
	Miscellaneous	Silencers	

Door Hardware Set No. 5

Location: Single Interior Door - Storeroom Function (Doors 107-1,109-1, 110-1, 120-1)

<u>Qty.</u>	<u>Description</u>	<u>Item</u>	<u>Finish</u>
<u>3</u>	<u>Hanging Devices</u>	<u>Hinges</u>	<u>626</u>
<u>1</u>	<u>Securing Device</u>	<u>Cylindrical Lockset Storeroom Function</u>	<u>626</u>
<u>1</u>	<u>Securing Device</u>	<u>Key Cylinder</u>	
<u>2</u>	<u>Protective Trim Units</u>	<u>Kick plate</u>	<u>630</u>
<u>1</u>	<u>Miscellaneous</u>	<u>Wall Stop</u>	
<u>1</u>	<u>Miscellaneous</u>	<u>Silencers</u>	

Door Hardware Set No. 6

Location: Building Entrance (Door 101-3)

Qty.	Description	Item	
2	Hanging Devices	Continuous Geared Hinge	
1	Exit Device (active leaf)	Rim Exit Device	630
1	Exit Device (inactive leaf)	Rim Exit Device (exposed vertical rod), blank exterior.	630
1	Securing Device	Key Cylinder	630
2	Operating Trim	Vertical Rod Pull	
1	Closer (inactive leaf)	Surface-mounted closer with Stop.	630
4	Protective Trim Units	Metal Kickplate	630
1	Accessories	Coordinator and Filler Bar	
1	Miscellaneous	Automatic Door Operator	
1	Miscellaneous	Door Switch (Exterior)	630
1	Miscellaneous	Door Switch (Interior)	630
1	Miscellaneous	Wall Actuator (Secure)	630
1	Miscellaneous	Wall Actuator (Non-secure)	630
1	Miscellaneous	Wireless Receiver	
1	Miscellaneous	Threshold - Type 1	Mill
1	Miscellaneous	Bollard Post	630
1	Miscellaneous	Electric Strike	
1	Miscellaneous	Flex Loop	
1	Miscellaneous	Card Reader (by Owner)	Black
1	Miscellaneous	Request to Exit Device	
1	Miscellaneous	Door Position Sensor	

2	Miscellaneous	Door Sweep	630
	Miscellaneous	Weatherstripping	
Door Hardware Set No. 7			

Double Doors From Entry (Doors 101-1, 101-2)

Qty.	Description	Item	
8	Hanging Devices	Hinge	626
1	Securing Device (active leaf)	Key Cylinder	626
1	Securing Device (active leaf)	Bored Lockset, Entrance function	626
1	Securing Device (inactive leaf - bottom)	Manual Flush Bolt with dust-proof strike	626
1	Securing Device (inactive leaf - top)	Automatic Flush Bolt	626
1	Closer (active leaf)	Surface closer with stop function.	626
2	Operating Trim (inactive leaf)	Flush Pulls	626
4	Protective Trim Units	Metal Kickplate	630
1	Holder or Stop	Wall Bumper	626
1	Accessories for Pairs of Doors	Astragal	630

Door Hardware Set No. 8

Double Doors into Storage (Doors 103-1)

8	Hanging Devices	Hinge	
1	Securing Device (active leaf)	Key Cylinder	
1	Securing Device (active leaf)	Bored Lockset, Storeroom function	
1	Securing Device (inactive leaf - bottom)	Manual Flush Bolt with dust-proof strike	
1	Securing Device (inactive leaf - top)	Constant-Latching Flush Bolt	
1	Closer	Surface closer with stop function	
2	Operating Trim (inactive leaf)	Flush Pulls	
2	Protective Trim Units	Metal Kickplate	
2	Miscellaneous	Hat and Coat Hook	

Door Hardware Set No. 9

Single Door into Weapons Vault, with Card Reader Access (Wall Bumper), *Fail-Secure Operation* (Door 105-1)

Qty.	Description	Item	
4	Hanging Devices	Hinge	626
1	Securing Device	Bored lockset, Storeroom function.	626
1	Securing Device	Key Cylinder	626
1	Closer	Surface closer with stop function	626
2	Protective Trim Units	Metal Kickplate	630
1	Holder or Stop	Wall Bumper	626
1	Miscellaneous	Electric Strike	
1	Miscellaneous	Card Reader (by Owner)	
2	Miscellaneous	Hat and Coat Hooks	
1 set	Miscellaneous	Perimeter Gasketing	

Door Hardware Set No. 10

Location: Overhead Coiling Door (Door 102-1, 103-3)

Qty.	Description	Item	Finish
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1 Securing Device Key Cylinder

Door Hardware Set No. 11

Single Door to Exterior (Door 111-1, 120-2)

Qty.	Description	Item
4	Hanging Devices	Hinge
1	Securing Device	Bored Lockset with Entrance function
1	Securing Device	Key Cylinder
1	Closer	Surface Closer with Stop
2	Protective Trim Units	Metal Kickplate
1	Miscellaneous	Threshold - Type 2
1	Miscellaneous	Door Position Sensor
1	Miscellaneous	Door Sweep
1 set	Miscellaneous	Weatherstripping

END OF SECTION 087100

SECTION 088000

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 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. Glass for windows, doors, interior borrowed lites, storefront framing, and glazed curtain walls.
 - a. Non-fire-resistive glazing.
 - 2. Glazing sealants and accessories.

1.4 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.

1.5 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.6 ACTION SUBMITTALS

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

- B. Glass Samples: For each type of glass or glazed unit; 12 inches square.
 - 1. Insulating glass.
- C. Glazing Accessory Samples: For sealants and colored spacers, in 12-inch lengths. Install sealant Samples between two strips of material representative in color of the adjoining framing system.
- D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturers of insulating-glass units with sputter-coated, low-E coatings.
- B. Product Certificates: For glass.
- C. Product Test Reports: For 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 18-month period.
- D. Preconstruction adhesion and compatibility test report.
- E. Sample Warranties: For special warranties.

1.8 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.

1.9 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. Testing is not required if data are submitted based on recent testing of current sealant products and glazing materials identical to those submitted. Results from tests within six months prior to submittal date are acceptable.
 - 2. 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.

3. Test no fewer than six Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
4. Schedule enough time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

1.10 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.

1.11 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.

1.12 WARRANTY

- A. 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: 10 years from date of Substantial Completion.
- B. 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: 10 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 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. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E 1300.
 - 1. Design Wind Pressures: As indicated on Drawings.
 - 2. Thickness of Patterned Glass: Base design of patterned glass on thickness at thinnest part of the glass.
 - 3. 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 3/4-inch, whichever is less.
- C. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
- D. 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. For laminated-glass lites, properties are based on products of construction indicated.
 - 2. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
 - 3. 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.
 - 4. 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.
 - 5. 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: "Laminated Glazing Reference Manual" and "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 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. 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.
 - 1. Minimum Glass Thickness: 6 mm.

2.4 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.
- B. Fully Tempered Float Glass Type G-1: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear), Quality-Q3.
 - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
 - 2. Glass Type GL-1: Clear fully tempered float glass.
 - a. Minimum Thickness: 6 mm.
 - b. Safety glazing required.
- C. Fully Tempered Float Glass with Low-E Coating Type IG-1: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear), Quality-Q3.
 - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
 - 2. Manufacturer:: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following
 - a. Guardian
 - b. Vitro PPG (Basis of Design)
 - c. Viracon
 - d. Or equal as approved by the Professional
 - 3. Basis of Design
 - a. Vitro
 - b. Product: Solarban 60 3 surfaces.
 - c. Solar Heat Gain Coefficient (SHGC): 0.13.
 - d. Visible Light Transmittance: 07 percent.
 - e. Coating Type: Pyrolytic.
 - f. Low-E Coating Location: Three surfaces.

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 polyisobutylene and silicone primary and secondary sealants.
 - 2. Perimeter Spacer: Aluminum with black, color anodic finish.
 - 3. Desiccant: Molecular sieve or silica gel, or a blend of both.
 - 4. Winter Nighttime U-Factor: 0.24 maximum.
 - 5. Visible Light Transmittance: 23 percent maximum.
 - 6. Solar Heat Gain Coefficient: 0.39 maximum.
- B. Insulated Glass Type IG-1: Low-E-coated, clear insulating laminated glass.
 - 1. Overall Unit Thickness: 1 inch.
 - 2. Minimum Thickness of Outdoor Lite: 6 mm.
 - 3. Outdoor Lite: Fully tempered clear float glass with Low-E coating.
 - 4. Interspace Content: Argon.
 - 5. Indoor Lite: Clear laminated glass with two plies of fully tempered float glass.
 - a. Minimum Thickness of Each Glass Ply: 3/16".
 - b. Total Glass Thickness: 3/8-inch, minimum.

- c. Reduce size of glazing spacer to accommodate laminated glazing.
 - d. Interlayer Thickness: 0.030 inch.
 - e. Safety glazing required.
- C. Laminated Glass: ASTM C1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following
 - a. Safeflex (Basis of Design)
 - b. Eastman Chemical Company.
 - c. Kuraray America, Inc.
 - d. Or equal as approved by the Professional
 - 2. Construction: Laminate glass with polyvinyl butyral interlayer or ionoplast interlayer to comply with interlayer manufacturer's written instructions.
 - 3. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
 - 4. Interlayer Color: Clear unless otherwise indicated.

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. VOC Emissions for Sealants: Provide certificate of compliance with California Department of Public Health (CDPH) Standard Method v1.1-2010, using the applicable exposure scenario.
 - 4. VOC Content for Sealants: Provide documentation of compliant VOC content per SCAQMD Rule 1168.
 - 5. Colors of Exposed Glazing Sealants: Black.
- B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following
 - a. Dow.(Basis of Design)
 - b. Kuraray America, Inc.
 - c. Tremco
 - d. Or equal as approved by the Professional
 - 2. (Basis of Design) Dowsil 995 Structural Glazing Sealant
 - 3. Colors of Exposed Glazing Sealants: Grey.

2.7 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. 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.
 - 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.

3.4 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. For laminated glass, the laminated pane shall be adhered to its supporting frame using structural silicone sealant. The structural silicone sealant bite shall be equal to the larger of 3/8-in. (10-mm) or the thickness of the laminated glass to which it adheres. The minimum thickness of the structural silicone bead shall be 3/16-in. (5-mm). The structural silicone bead or glazing tape shall be applied to both sides of single pane laminated glass but need only be applied to the inboard (protected) side of an IGU. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.5 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.
- D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 088000

SECTION 092216

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 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. Non-load-bearing steel framing systems for interior partitions.
 - 2. Suspension systems for interior ceilings and soffits.
 - 3. Grid suspension systems for gypsum board ceilings.

1.4 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. 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.
- B. Horizontal Deflection: For wall assemblies, limited to 1/240 of the wall height based on horizontal loading of 10 lbf/sq. ft.

2.2 FRAMING SYSTEMS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

- B. EPD for Metal Framing: Provide a product-specific Type III EPD in accordance with ISO 14025 and has at least a cradle to gate scope.
- C. HPD for Metal Framing: Provide a complete Health Product Declaration with full disclosure of known hazards in compliance with the Health Product Declaration Open Standard.
- D. Regional Material for Metal Framing: Provide documentation indicating distance to project site, cost for each regional material and fraction by weight that is considered regional.
- E. Recycled Content of Metal Framing: Provide documentation indicating postconsumer recycled content plus one-half of preconsumer recycled content of at least 25%.
- F. Available Manufacturers: Subject to compliance with project requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - 1. Dietrich (Basis of Design)
 - 2. MBA Metal Framing.
 - 3. MRI Steel Framing.
 - 4. The Steel Network.
 - 5. Or equal as approved by the Professional.
- G. 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:
 - a. ASTM A 653, G40 unless otherwise noted.
 - b. Protective Coating: ASTM A 653, G90
 - 1) Entry. 101
 - 2) Men's 117
 - 3) Women's 118
- H. Studs and Runners: ASTM C 645.
 - 1. Minimum Base-Metal Thickness: 20 gauge unless otherwise noted.
 - a. 14 gauge thickness to brace toilet partitions in Men 115, Women 116, Men 215, and Women 217.
 - 2. Depth: As indicated on Drawings.
- I. Slip-Type Head Joints: Provide one of the following at non-load-bearing partitions:
 - 1. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch-deep flanges in thickness not less than indicated for studs 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 applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- J. Cold-Rolled Channel Bridging: Steel, 18 gauge minimum base-metal thickness, with minimum 1/2-inch-wide flanges.
 - 1. Depth: 1-1/2 inches.
 - 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch-thick, galvanized steel.

- K. Resilient Furring Channels: 1/2-inch-deep, steel sheet members designed to reduce sound transmission.
 - 1. Configuration: Asymmetrical or hat shaped.
- L. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
 - 1. Minimum Base-Metal Thickness: 20 gauge unless otherwise noted.
 - 2. Depth: As indicated on Drawings.
- M. 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 20 gauge and depth required to fit insulation thickness indicated.

2.3 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
 - 1. 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: Asphalt-saturated organic felt, ASTM D 226, Type 1 (No. 15 asphalt felt), non-perforated.

2.4 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. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.
- C. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch and minimum 1/2-inch-wide flanges.
 - 1. Depth: 1-1/2 inches.
- D. Furring Channels (Furring Members):
 - 1. Cold-Rolled Channels: 20 gauge 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: 20 gauge.
 - b. Depth: 3-5/8 inches.
 - 3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.
 - a. Minimum Base-Metal Thickness: 20 gauge.
- E. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
 - 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. Armstrong World Industries, Inc; Drywall Grid Systems. (Basis of Design)
 - b. Chicago Metallic Corporation; 640/660 Drywall Ceiling Suspension.
 - c. United State Gypsum Company; Drywall Suspension System.
 - d. Or equal as approved by the Professional

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 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 framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.3 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.
 - 2. Multilayer Application: 16 inches o.c.
- 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 that penetrate 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. 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. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
- E. 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.

END OF SECTION 092216

SECTION 092900

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 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. Interior gypsum board.
- B. Related Requirements:
 - 1. Section 092216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.
 - 2. Section 093013 "Ceramic Tiling" for cementitious backer units installed as substrates for ceramic tile.
 - 3. Section 099123 "Interior Painting" for primer and its application to gypsum board surfaces.

1.4 ACTION SUBMITTALS

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

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 gypsum board manufacturer's written instructions, 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, 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sound Isolation Partitions: For sound isolation partitions, 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.
- B. General Emissions Evaluation for Gypsum Board: Provide third-party certified documentation of compliance with California Department of Public Health CDPH/EHLB/Standard Method Version 1.1, 2010.

2.2 GYPSUM BOARD, GENERAL

- A. Manufacturers- Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Armstrong World Industries, Inc. (Basis of Design).
 - 2. CertainTeed Corp.
 - 3. USG Interiors, Inc.; Subsidiary of USG Corporation.
 - 4. Or equal as approved by the Professional.
- B. EPD for Gypsum Board: Provide a product-specific Type III EPD in accordance with ISO 14025 and has at least a cradle to gate scope.
- C. HPD for Gypsum Board: Provide a complete Health Product Declaration with full disclosure of known hazards in compliance with the Health Product Declaration Open Standard.
- D. Regional Material for Gypsum Board: Provide documentation indicating distance to project site, cost for each regional material and fraction by weight that is considered regional.
- E. Recycled Content of Gypsum Board: Provide documentation indicating postconsumer recycled content plus one-half of preconsumer recycled content of at least 25%.
- F. 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. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. CertainTeed Corporation. (Basis of Design)

2. Georgia-Pacific Building Products.
 3. National Gypsum Company.
 4. USG (United States Gypsum).
 5. Or equal as approved by the Professional
- B. Gypsum Board, Type X: ASTM C 1396.
1. Thickness: 5/8 inch.
 2. Long Edges: Tapered.
- C. Gypsum Ceiling Board: ASTM C 1396.
1. Thickness: 1/2 inch.
 2. Long Edges: Tapered.
- D. Mold-Resistant Gypsum Board: ASTM C 1396. With moisture- and mold-resistant core and paper surfaces.
1. Core: 5/8 inch, Type X.
 2. Long Edges: Tapered.
 3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274
 4. Locations:
 - Entry. 101
 - Men's 117
 - Women's 118
- E. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or ASTM C1325, with manufacturer's standard edges.
1. Thickness: **5/8 inch (15.9 mm)**
 2. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.
 3. Locations
 - Men's 117- Shower and Dressing Area
 - Women's 118 – Shower and Dressing Area

2.4 TRIM ACCESSORIES

- A. Aluminum Trim: ASTM B 221, Alloy 6063-T5. Extruded accessories of profiles and dimensions indicated.
1. Finish: Primed for field painting.
- B. Manufacturers: Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
- a. Fry-Reglet Corporation (Basis of Design).
 - 1) Corner Trim: DMCT Series.
 - 2) Edge Trim: DRML Series
 - 3) GWB Expansion Joints: DRM Series
 - 4) Wall End Trim: DMEC Series
 - 5) Z Reveal: DRMZ Series
 - b. Gordon, Inc.
 - c. Milgo-Bufkin.
 - d. Pittcon Industries.
 - e. Or equal as approved by the Professional

2.5 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
 - 1. Interior Gypsum Board: Paper.
- 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, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
 - 2. All locations unless noted otherwise:
 - a. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
 - 1) Use setting-type compound for installing paper-faced metal trim accessories.
 - b. Fill Coat: For second coat, use drying-type, all-purpose compound.
 - c. Finish Coat: For third coat, use drying-type, all-purpose compound.
 - d. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound.
 - 3. Rooms with mold-resistant gypsum board:
 - a. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
 - b. Fill Coat: For second coat, use setting-type, curing compound.
 - c. Finish Coat: For third coat, use setting-type, curing compound.

2.6 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
 - 1. VOC Emissions for Adhesives: Provide certificate of compliance with California Department of Public Health (CDPH) Standard Method v1.1-2010, using the applicable exposure scenario.
 - 2. VOC Content for Adhesives: Provide documentation of compliant VOC content per SCAQMD Rule 1168.
- C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
- D. Sound-Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 - 1. Recycled Content of Blankets: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 70 percent.
 - 2. EPD for Glass-Fiber Blanket: Provide an industry-wide EPD in accordance with ISO 14025 and has at least a cradle to gate scope.
 - 3. HPD for Glass-Fiber Blanket: Provide a complete Health Product Declaration with full disclosure of known hazards in compliance with the Health Product Declaration Open Standard.

4. General Emissions Evaluation for Glass-Fiber Blanket: Provide third-party certified documentation of compliance with California Department of Public Health CDPH/EHLB/Standard Method Version 1.1, 2010.
 5. Recycled Content of Glass-Fiber Blanket: Provide documentation indicating postconsumer recycled content plus one-half of preconsumer recycled content.
- E. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
- F. 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
- a. Armstrong World Industries, Inc. (Basis of Design)
 - b. Pecora Corporation.
 - c. USG Corporation
 - d. Or equal as approved by the Professional.
2. VOC Emissions for Sealants: Provide certificate of compliance with California Department of Public Health (CDPH) Standard Method v1.1-2010, using the applicable exposure scenario.
3. VOC Content for Sealants: Provide documentation of compliant VOC content per SCAQMD Rule 1168.

PART 3 - EXECUTION

2.7 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- 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.

2.8 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. 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. Sound Isolation Partitions: 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 instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

2.9 APPLYING INTERIOR GYPSUM BOARD

- A. 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 vertically (parallel 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.
 - 3. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- B. Multilayer Application:
 - 1. 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.
 - 2. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

2.10 INSTALLATION OF TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A108.11, at **showers and dressing area**

2.11 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 at locations indicated on Drawings.
- C. Aluminum Trim: Install in the following locations:
 - 1. Cornerbead: Use at outside corners.
 - 2. Other trim profiles: Install in locations indicated on Drawings.

2.12 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, beveled edges, 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 and concealed areas.
 - 2. Level 4: Panel surfaces that will be exposed to view.

2.13 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 092900

SECTION 093013

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 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. Porcelain tile.
 - a. Wall tile WT-1.
 - b. Wall tile WT-2
 - 2. Metal edge strips.
- B. Related Requirements:
 - 1. Section 079200 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.

1.4 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. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification:
 - 1. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required. Make samples at least 24 inches square, but not fewer than four partial tiles. Use grout of type and in color or colors approved for completed Work.
 - 2. Metal edge strips in 6-inch lengths.
 - 3. Crack-isolation membrane, 12-inch square sample.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of product.
- C. Product Test Reports: For tile-setting and -grouting products and certified porcelain tile.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Tile Units: Furnish quantity of full-size units equal to at least 5 percent of amount installed for each type, composition, color, pattern, and size indicated, but not less than the following:
 - a. WT-1
 - b. WT-2
 - 2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer is a five-star member of the National Tile Contractors Association or a Trowel of Excellence member of the Tile Contractors' Association of America.

1.9 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.

1.10 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. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Dal Tile (Basis of Design)
 - 2. Crossville
 - 3. Marazzi
 - 4. Or equal as approved by the Professional
- B. Basis-of-Design Product:
 - 1. Manufacturer: Dal Tile
 - 2. Product: **WT-1**- Synchronic Tile in White Matte 12x24
 - 3. Product: **WT-2**- Synchronic Tile in White Matte 1x6
- C. Source Limitations for Tile: Obtain each type of tile 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.
- D. 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.
- E. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:
 - 1. Crack isolation membrane.
 - 2. 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.
- 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.

2.3 TILE PRODUCTS

- 1. postconsumer recycled content.

B. Ceramic Tile Type WT-1(Walls): Unglazed porcelain tile

- 1. Manufacturer: Daltile.
- 2. Products:
 - a. Match Point.
 - 1) Texture: Unpolished.
 - 2) Color: Pure White P125.
 - b. Unity.
 - 1) Texture: Unpolished.
 - 2) Color: Avorio B400.
- 3. Face Size: 11.65 inches by 23.42 inches.
- 4. Face Size Variation: Rectified.
- 5. Thickness: 5/16 inches.
- 6. Face: Plain with square edges.
- 7. Grout Colors: As selected by Architect from manufacturer's full range. Provide a different grout color for each wall tile color.
- 8. Internal Corners: Field-buttet square corners.
- 9. External Corners: Provide metal corner trim.

2.4 CRACK ISOLATION MEMBRANE

- A. General: Manufacturer's standard product, selected from the following, 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. Corrugated Polyethylene: Corrugated polyethylene with dovetail-shaped corrugations and with anchoring webbing on the underside; 1/8-inch nominal thickness.
- C. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following
- D. Manufacturers- Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Schluter Systems. (Basis of Design)
 Product: DITRA membrane.
 VOC Emissions for Adhesives: Provide certificate of compliance with California Department of Public Health (CDPH) Standard Method v1.1-2010, using the applicable exposure scenario.
 VOC Content for Adhesives: Provide documentation of compliant VOC content per SCAQMD Rule 1168.
 - 2. Noble Seal
 - 3. Laticrete
 - 4. Or equal as approved by the Professional

2.5 SETTING MATERIALS

- A. Portland Cement Mortar (Thinset):
 - 1. Type:
 - a. General: Modified, ANSI A118.4.
 - b. Over polyethylene membrane: Unmodified, ANSI A118.1
 - 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - a. Bostik, Inc. (Basis of Design)
 - b. Laticrete International, Inc.
 - c. MAPEI Corporation.
 - d. Or equal as approved by the Professional
 - 3. For floor application, provide mortar approved by manufacturer for application thickness up to 5/8-inch (medium-bed installation).
 - 4. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.

2.6 GROUT MATERIALS

- A. Standard Cement Grout: ANSI A118.6.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - a. Bostik, Inc.(Basis of Design)
 - b. Laticrete International, Inc.
 - c. MAPEI Corporation.
 - d. Or equal as approved by the Professional
 - 2. For glass mosaic tile installation, provide grout color recommended by tile manufacturer.
- B. VOC Emissions for Adhesives: Provide certificate of compliance with California Department of Public Health (CDPH) Standard Method v1.1-2010, using the applicable exposure scenario.
- C. VOC Content for Adhesives: Provide documentation of compliant VOC content per SCAQMD Rule 1168.
- D. Regional Materials: When available, aggregate for mortar and grout, cement, and lime shall be extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project Site.

2.7 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, designed specifically for flooring applications; stainless-steel, ASTM A 666, 300 Series exposed-edge material.
 - 1. Manufacturer- Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - a. Schluter Systems. (Basis of Design)

Product: SCHIENE edge trim.

- b. Laticrete
 - c. Sunwings
 - d. Or equal as approved by the Professional
- 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. Grout Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.
- 1. VOC Emissions for Sealers: Provide certificate of compliance with California Department of Public Health (CDPH) Standard Method v1.1-2010, using the applicable exposure scenario.
 - 2. VOC Content for Sealers: Provide documentation of compliant VOC content per SCAQMD Rule 1168.

2.8 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.
- D. Regional Materials: When available, aggregate for mortar and grout, cement, and lime shall be extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project Site.

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 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 thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- B. 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 CERAMIC 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. Installation 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. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
- E. Jointing Pattern: Lay tile in grid (stack-bond) 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. Install wall tiles horizontally, with long side parallel to floor.
 3. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
 4. Align joints between floor and base tiles.

- F. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
 - 1. Porcelain Tile: 1/4 inch.
- G. 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.
- H. Metal Edge Strips: Install at locations indicated on drawings, and where required to cover unfinished edge of tile.
- I. Sealer: Apply sealer to grout joints within floors and walls according to sealer manufacturer's written instructions. As soon as sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 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.

3.5 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 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.

3.6 PROTECTION

- A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear.
- 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 from tile surfaces.

3.7 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

A. Interior Wall Installations, CMU, Wood or Metal Studs or Furring:

1. Ceramic Tile Installation WT-1: TCNA W243; thinset mortar on mold-resistant gypsum board.
 - a. Thinset Mortar: Latex-portland cement mortar.
 - b. Grout: Standard sanded cement grout.

END OF SECTION 093013

SECTION 095113
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.

1.3 ACTION SUBMITTALS

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

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.5 EXTRA MATERIALS

- A. Furnish extra materials described below that are from same production run as materials installed and that are packaged for storage and identified with labels describing contents.
 - 1. Quantity: Furnish 10 panels of each type of panel installed.

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: Comply with ASTM E 1264 for Class A materials.
 - 2. Smoke-Developed Index: 50 or less.

2.2 ACOUSTICAL PANEL CEILINGS, GENERAL

- A. Acoustical Panel Standard: Comply with ASTM E 1264.
- B. Metal Suspension System Standard: Comply with ASTM C 635.

- C. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated.

2.3 ACOUSTICAL PANELS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Armstrong World Industries, Inc. (Basis of Design).
 - 2. CertainTeed Corp.
 - 3. USG Interiors, Inc.; Subsidiary of USG Corporation.
 - 4. Or equal as approved by the Professional.
- B. Basis-of-Design Product:
 - 1. Manufacturer: Armstrong World Industries, Inc.
 - 2. Product: Cortega.
- C. Classification: Type III, Form 2, Pattern C D as defined by ASTM E1264.
- D. Color: White.
- E. Edge/Joint Detail: Square Lay-in.
- F. Thickness: 5/8 inches.
- G. Modular Size: 24 by 24 inches.

2.4 METAL SUSPENSION SYSTEM

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Armstrong World Industries, Inc. (Basis of Design)
 - 2. CertainTeed Corp.
 - 3. Chicago Metallic Corporation.
 - 4. USG Interiors, Inc.; Subsidiary of USG Corporation.
 - 5. Or equal as approved by the Professional.
- B. Basis-of-Design Product:
 - 1. Manufacturer: Armstrong World Industries, Inc.
 - 2. Product: Prelude XL 15/16" Exposed Tee.
 - 3. Color and texture: White color to match ceiling panels; standard smooth texture.
- C. 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, G30 (Z90) coating designation; with prefinished 15/16-inch-wide metal caps on flanges.
 - 1. Structural Classification: Intermediate-duty system.
 - 2. End Condition of Cross Runners: butt-edge type.
 - 3. Face Design: Flat, flush.
 - 4. Cap Material: Cold-rolled steel.
 - 5. Cap Finish: Painted white.

- D. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Manufacturer's standard moldings for edges and penetrations; formed from extruded aluminum of same finish and color as that used for exposed flanges of suspension-system runners.

2.5 ACOUSTICAL SEALANT

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Acoustical Sealant for Concealed Joints:
 - a. Armstrong World Industries, Inc. (Basis of Design)
 - b. Pecora Corporation.
 - c. Tremco, Inc.
 - d. Or equal as approved by the Professional.
- B. Acoustical Sealant: Manufacturer's standard sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
 - 1. Concealed Joints: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant.
 - 2. Acoustical sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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. Start of installation will be construed as acceptance of pre-installation conditions.

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, 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. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 6. 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.
 7. Do not attach hangers to steel deck tabs.
 8. 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.
 9. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. 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 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.
- D. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- E. 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.

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 095113

SECTION 096513

RESILIENT BASE 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 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. Resilient base.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 12 inches long.

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. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.6 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: 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.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products 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 .

1.8 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following time 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. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 THERMOSET-RUBBER BASE: RB-1

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Roppe Corporation, USA. (Basis of Design)
 - 2. Manville
 - 3. Armstrong
 - 4. Or equal as approved by the Professional.
- B. Product Standard: ASTM F 1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).
 - 1. Style: Cove
- C. Thickness: 0.125 inch .
- D. Height: 4 inches.
- E. Lengths: Coils in manufacturer's standard length.
- F. Outside Corners: Job formed.
- G. Inside Corners: Job formed.
- H. Colors: 150 Dark Grey

2.2 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.
 - 1. VOC Emissions for Wet-Applied Adhesives: Provide certificate of compliance with California Department of Public Health (CDPH) Standard Method v1.1-2010, using the applicable exposure scenario.
 - 2. VOC Content for Wet-Applied Adhesives: Provide documentation of compliant VOC content per SCAQMD Rule 1168.
- C. Stair-Tread Nose Filler: Two-part epoxy compound recommended by resilient stair-tread manufacturer to fill nosing substrates that do not conform to tread contours.

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 products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- C. Do not install resilient products until they are the same temperature as the space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
- D. Immediately before installation, sweep and vacuum substrates to receive resilient products.

3.3 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. Preformed Corners: Install preformed corners before installing straight pieces.

3.4 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. Resilient Stair Accessories:
 - 1. Use stair-tread-nose filler to fill nosing substrates that do not conform to tread contours.
 - 2. Tightly adhere to substrates throughout length of each piece.
- C. 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.

3.5 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 exposed surfaces.
- 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 products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 096513

SECTION 096519

RESILIENT TILE 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 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of resilient floor tile.
 - 1. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
 - 2. Show details of special patterns.
- C. Samples for Verification: Full-size units of each color and pattern of floor tile required.
 - 1. For heat-welding bead, manufacturer's standard-size Samples, but not less than 9 inches long, of each color required.
- D. Sample applied to a rigid backing and prepared by Installer for this Project.

1.3 VINYL COMPOSITION FLOOR TILE <VCT-1>

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:≥
 - 1. Armstrong – Basis of Design
 - 2. Tarkett
 - 3. Mannington
 - 4. Or equal as approved by the Professional
- B. Basis of Design:
 - 1. Armstrong Flooring Standard Excelon Imperial Texture
 - Wearing Surface: Smooth
 - Thickness: 0.125 inch (3.2 mm)
 - Size: 12 by 12 inches (305 by 305 mm).
 - Color :Sterling 51904

1.4 EXAMINATION

- A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.

- B. Perform the following operations immediately after completing floor tile 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 floor tile from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

1.5 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- 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, existing adhesives, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
 - 4. Moisture Testing: Perform tests recommended by floor covering manufacturer. Proceed with installation only after substrates pass testing.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install floor tiles until they are same temperature as space where they are to be installed.
 - 1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- E. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

1.6 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Install copper grounding strips as recommended by Manufacturer to provide the static-dissipative performance specified. Size and spacing of grounding strips to comply with Manufacturer's directions.
- C. 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. Lay tiles square with room axis.
- D. 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. Lay tiles in monolithic pattern.

- E. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- F. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.
- H. Adhere floor tiles to flooring 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.

1.7 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of floor tile.
- B. Comply with manufacturer's written instructions for cleaning and protecting floor tile.
- C. Perform the following operations immediately after completing floor tile installation:
 - 1. Remove adhesive and other blemishes from surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
- D. Protect floor tile from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

SECTION 096623
RESINOUS FLOORING

PART 1 – GENERAL

1.1 STIPULATIONS

- A. Retain or delete this article in all Sections of Project Manual. 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. Troweled urethane cement composition flooring with slip-resistant broadcast, designated as “Epoxy” on drawings.
 - 2. Integral cove base of same material as flooring.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's specifications, installation instructions, and general recommendations for resinous flooring materials. Include data substantiating that products to be furnished comply with requirements of the contract documents.
- B. Shop Drawings
- C. Samples: Submit complete sets of samples, illustrating full range of color and texture to be expected in the completed work. Provide samples of minimum 6-inch squaresize.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A firm which has completed, within the last 3 years, at least 3 resinous flooring applications similar in type and scope to that required for this project.
- B. Manufacturer's Field Service: Manufacturer's representative shall be present on the site to assist in evaluation of substrates and to provide recommendations in the proper installation of system.
- C. Source Limitations: Each product type from single manufacturer ensuring uniformity.

1.5 PRE-INSTALLATION CONFERENCE

- A. Pre-installation Meetings: Coordinate work of this Section, with related work.
 - 1. Attendance: Subcontractor performing work and manufacturers and fabricators involved, or affected by, installation. Coordinate installations that precede or follow.
 - 2. Agenda: Review progress of construction activities and preparations for the particular

- activity under consideration. Agenda shall include schedule, drain and floor sink interface, detailing, door thresholds, responsibilities, critical path items, and approvals.
3. Record, agreements, and disagreements, and corrective measures and actions.
 4. Reporting: Distribute minutes to each party present and others requiring information.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect materials from excessive moisture in shipment, storage, and handling. Deliver materials in manufacturer's unopened packages, and store in dry place with adequate air circulation.
- B. Keep materials dry at all times. Protect against exposure to weather and against contact with damp or wet surfaces.

1.7 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, surface temperature, material temperature and ventilation) within limits recommended by manufacturer during installation and cure. Do not install under conditions outside manufacturer's recommended limits.
- B. Restrict access to Work area except installing contractor and site supervision during preparation, installation and cure period.
- C. Lighting: Permanent lighting shall be in place prior to flooring installation.

PART 2 – PRODUCTS

2.1 MANUFACTURER

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 1. Sherwin Williams: Resuflor (Basis of Design)
 2. Dex o Tex
 3. General Polymers Corp.
 4. Sika Corp.
 5. Or equal as approved by the Professional.

2.2 EPOXY FLOORING

- A. Resuflor Deco Quartz DB23. (Basis of Design Product)
 1. First Broadcast Coat with decorative quartz broadcast: Resuflor MPE, 10-12 mils.
 2. Second Broadcast Coat with decorative quartz broadcast: Resuflor MPE, 15 mils.
 3. Grout Coat: Resuflor UVE, 15 mils.
 4. Topcoat: Resutile HTS 100, 3 mils.
 5. Color: Foggy Morning

6. SYSTEM PROPERTIES

Tennant Quartz DB

1. Abrasion Resistance, Taber Abraser CS-17 Taber Abrasion Wheel, 1,000 gram load, 1,000 revolutions, ASTM D4060, 18 mg/loss

2. Adhesion to Concrete, psi [MPa], ASTM D4541, 450 [3.10] (concrete failed)
3. Adhesion to Concrete, psi [MPa], ASTM D7234, 732 [4.48] (concrete failed)
4. Coefficient of Friction-COF, James Friction Tester, ASTM D2047, 0.63
5. Coefficient of Friction-Wet Static, BOT 3000, ANSI/NFSI B101.1, 0.94
6. Compressive Strength, psi [MPa], ASTM D695, 13,500 [93.079]
7. Flammabilitymm/min, ASTM D635, 182 mm/min
8. König Hardness, ASTM D22540, 171.3
9. Shore D hardness, ASTM D2240, 80-85 @ 0 sec | 75-80 @ 15 sec
10. Sward Hardness (1mil flim), ASTM D2240, 30-40
11. Tensile Strength, psi [MPa], ASTM D2370, 8,000 [55.158]
12. Percent Elongation (resin only), ASTM D2370, 6%
13. Volatile Organic Compound, VOC,lb/gal [g/l], ASTM D3960, Resuflor MPE A+B= 0.41 [49]
Resuflor UVE A+B=0.67 [81] Resutile HTS 100 A+B+C=0.05 [6]
14. Water Absorption (24 hours), ASTM D570, 0.2% weight increase

PRODUCT PROPERTIES

Resuflor MPE: A neutral, two-component, high solids epoxy.

1. Percent Solids, by weight (by volume), ASTM D1475, A + B: 95.45 (94.56).
2. Volatile Organic Compound-VOC, ASTM D3960, Mixed A + B: 0.41 lb./gal (49 g/L).
3. Abrasion Resistance, mg loss, Taber Abraser, C-17 Taber Abrasion Wheel, 1,000 gram load, 1,000 revolutions, ASTM D4060: 83.1.
4. Coefficient of Friction-COF, James Friction Tester, ASTM D2047: 0.59-0.62.
5. Adhesion to Concrete, ASTM D5441: 732 psi (4.48 MPa) concrete failed.
6. Adhesion to Concrete, ASTM D7234: 450 psi (3.10 MPa) concrete failed.
7. Compressive Strength, ASTM D695: 13,500 psi (93.079 MPa).
8. Tensile Strength, ASTM D2370: 8,000 psi (55.158 MPa).
9. Percent Elongation, ASTM D2370: 5.
10. Shor D Hardness, ASTM D2240: 80-85 @ 0 sec, 75-80 @ 15 sec.

3.1 EXAMINATION

- A. Do not begin preparation and installation until substrates are properly constructed and inspected complying with ACI 311.4R-05 Guide for Concrete Inspection. Correct non-conformities if defects are discovered. Repair per ACI 546.R-04. Turn over work in broom clean condition free of debris and foreign matter.
- B. Perform moisture testing per ASTM F1869 and F2170. Document results per this specification. If MVER or RH exceeds manufactures recommend level for specified product. Apply vapor control primer before proceeding.
- C. Do not proceed with flooring installation until the conditions are corrected. Start of installation will be construed as acceptance of substrate conditions.

3.2 PREPARATION

- A. Inspect substrates and conditions under which the resinous flooring work will be performed, and verify that installation properly may commence. Do not proceed with the work until unsatisfactory conditions have been resolved fully.
- B. Clean substrate, removing projections and substances detrimental to the work; comply with recommendations of manufacturer of products to be installed for proper preparation

procedures.

1. Where curing compounds are present, completely remove compounds by sandblasting.
2. Remove all traces of oil, dirt, and other contamination to achieve a clean substrate.
3. After achieving a clean substrate, etch with a 10 percent muriatic acid solution applied in strict accordance with manufacturer's instructions. Completely remove spent solution from surface by several generous flushings of water.

- C. Cut 1/8" X 1/2" keyways around the perimeter, around drains, clean outs, access panels or other flooring interruption, and at expansion or isolation joints.
- D. Prime substrate in accordance with recommendations of manufacturer for optimum installed performance.

3.3 APPLICATION

- A. General: Apply each component of resinous flooring system to comply with manufacturer's instructions to produce a uniform monolithic wearing surface of thickness indicated, interrupted only at sawn joints or other types of joints (if any)
- B. Prime Coat: Apply primer over prepared substrate at manufacturer's recommended spreading rate. Coordinate mixing timing of primer application with application of topping mix to ensure optimum adhesion between resinous flooring materials and substrate.
- C. Troweled Application of Topping Mix: Trowel-apply underlayment and topping mix including fine aggregates or fillers over freshly applied primer in number of coats and at spreading rates required to produce slopes and levels as shown on drawings, with minimum thickness of 1/8 inch. Check thickness at frequent intervals by methods recommended by manufacturer. Perform finish troweling as work proceeds.
 1. Aggregates: Broadcast aggregates at rate recommended by manufacturer. After resin cures, remove excess aggregates. Provide cleanable, non-slip surface texture indicated.
- D. Finish or Sealing Coat: After topping mix has cured sufficiently, apply finish or sealing coat of type required to produce satin finish, and in number of coats and spreading rates recommended by manufacturer.
- E. Cove Base: Apply floor system to wall surfaces to form base with cove or radius required and a height of 4 inches unless otherwise indicated. Round interior and exterior corners.
- F. Joints: Where substrate is interrupted by control joint, provide joint in resinous flooring as recommended by manufacturer.
 1. Apply single component polyurethane joint sealant complying with ASTM C 920, Type S, Class 25, Use T.
- G. Curing: Cure resinous flooring materials in accordance with manufacturer's directions, taking care to prevent contamination during stages of application and prior to completion of curing process.

3.4 CLEANING AND PROTECTION

- A. Upon completion, clean all surfaces which have become soiled or coated as a result of work of this section, using proper methods which will not scratch or otherwise damage finished surfaces.
 1. For cleaning, use only products and techniques acceptable to manufacturer of products being cleaned.
- B. Protect resinous flooring from damage and wear during construction operations. Comply with

manufacturer's recommendations for protective materials and methods of application. Remove temporary covering and clean flooring just prior to substantial completion.

- C. Touch-up, repair, or replace damaged portions of resinous flooring prior to Substantial Completion

PROTECTION

- D. General: Institute protective procedures and install protective materials as required to ensure that work of this section will be without damage or deterioration at substantial completion.

END OF SECTION 096623

SECTION 096850

TILE 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 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 modular carpet tile.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For each exposed product and for each color and texture specified.

C. INFORMATIONAL SUBMITTALS

- C. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.
- B. Fire-Test-Response Ratings: Where indicated, provide carpet tile identical to those of assemblies tested for fire response according to NFPA 253 by a qualified testing agency.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI 104.

1.8 FIELD CONDITIONS

- A. Comply with CRI 104 for temperature, humidity, and ventilation limitations.

1.9 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, more than 10 percent edge raveling, snags, runs, dimensional stability, loss of tuft bind strength, loss of face fiber, and delamination.
 - 3. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Interface. (Basis of Design).
 - 2. Shaw
 - 3. Mohawk
 - 4. Or equal as approved by the Professional.
- B. CPT-1
 - Manufacturer: Interface
 - Size: Tiles will be 50 cm by 50 cm.
 - Model: Detours Ahead Tile
 - Color: Steel/Tonal
- C. CPT-2
 - Manufacturer: Interface
 - Size: Tiles will be 50 cm by 50 cm.
 - Model: SR999
 - Color: Iron

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 complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.

PART 3 - EXECUTION

3.1 INSTALLATION

- 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. Examine carpet tile for type, color, pattern, and potential defects.
- B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710.
- C. Proceed with installation only after unsatisfactory conditions have been corrected. Start of installation will be construed as acceptance of existing conditions.
- D. Preparation: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.
- E. Installation: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.
- F. Installation Method: Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive.
- G. Maintain dye lot integrity. Do not mix dye lots within Project.
- H. 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.
- I. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- J. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.
- K. Install pattern parallel to walls and borders.
- L. Install carpet tile in any of the following patterns. Architect will make final selection based on carpet tile pattern.
 - 1. Quarter-turn.
 - 2. Monolithic.
 - 3. Ashlar (staggered).
- M. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive, seam sealer, 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.
- N. Protect installed carpet tile to comply with CRI 104, Section 16, "Protecting Indoor Installations."

END OF SECTION 096850

SECTION 099120

INTERIOR AND 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 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 surface preparation and the application of paint systems on the following interior substrates:
 - 1. Concrete masonry units (CMU).
 - 2. Concrete
 - 3. Steel.
 - 4. Aluminum (not anodized or otherwise coated).
 - 5. Gypsum board.
 - 6. Wood.
 - 7. Exterior Metal
- B. Related Sections:
 - 1. Division 04 Section "Maintenance of Unit Masonry" for exterior Antirust Coating.

1.4 DEFINITIONS

- A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
 - 1. Flat.
- B. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
 - 1. Eggshell.
- C. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
 - 1. Semi-Gloss.

1.5 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 in each color and gloss of topcoat.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Benjamin Moore & Co.
 - 2. PPG Pittsburgh Paints.
 - 3. Sherwin-Williams Company (Basis-of-Design).
 - 4. Or equal as approved by the Professional

2.2 PAINT, GENERAL

- A. 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.
- B. VOC Content: 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. Primers, Sealers, and Undercoaters: 200 g/L.
 - 4. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
 - 5. Pretreatment Wash Primers: 420 g/L.
- C. Low-Emitting Materials: Interior 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."
- D. VOC Emissions for Interior Paints and Coatings: Provide certificate of compliance with California Department of Public Health (CDPH) Standard Method v1.1-2010, using the applicable exposure scenario.

- E. VOC Content for Interior Paints and Coatings: Provide documentation of compliant VOC content per SCAQMD Rule 1113.

- F. Colors: (Basis of Design)

Interior:

1. PT-1: Walls (Typical), – SW 7551 Greek Villa
2. PT-2: Accent (Offices) - SW 9129 Jade Dragon
3. PT-3: Accent (Corridors) -SW 6221 Moody Blue
4. PT-4: Accent (Toilets)-SW 9381 Anjou Pear
5. PT-5: Accent (Exposed Structure/Decking)-SW 9163 Tin Lizzie
6. PT-6: Accent (Door Trim)-SW 9163 Tin Lizzie
7. PT-7: Accent (Exterior Door and Trim) – Match MP Panel

2.3 PRIMERS/SEALERS

- A. Primer Sealer, Latex, Interior:

1. ProMar 200 Zero VOC.

2.4 METAL PRIMERS

- A. Primer, Rust-Inhibitive, Interior:

1. Pro-Cryl Universal Primer.

- B. Primer, Galvanized, Water Based:

1. Pro-Cryl Universal Primer.

2.5 WATER-BASED PAINTS

- A. Latex, Interior, Flat, (Gloss Level 1):

1. ProMar 200 Zero VOC.

- B. Latex, Interior, (Gloss Level 3):

1. ProMar 200 Zero VOC.

- C. Latex, Interior, Semi-Gloss, (Gloss Level 5):

1. ProMar 200 Zero VOC.
2. Solo Latex.
3. ProIndustrial High-Performance Acrylic.

- D. Latex, Exterior, Semi-Gloss, (Gloss Level 5):

1. ProIndustrial DTM Latex

2.6 SOLVENT-BASED PAINTS

- A. Alkyd, Interior, Semi-Gloss (Gloss Level 5):

1. Industrial Enamel 100.

2.7 CONCRETE SEALER

- A. Waterbased sealer (Gloss Level 3):
 1. Cementone Clear Sealer by Scofield.
- B. VOC Emissions for Interior Paints and Coatings: Provide certificate of compliance with California Department of Public Health (CDPH) Standard Method v1.1-2010, using the applicable exposure scenario.
- C. VOC Content for Interior Paints and Coatings: Provide documentation of compliant VOC content per SCAQMD Rule 1113.

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. Masonry (Clay and CMU): 12 percent.
 2. Wood: 15 percent.
 3. Gypsum Board: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
 1. Plaster Substrates: Verify that plaster is fully cured.
- D. 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 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.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
- B. 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.

3.4 CLEANING AND PROTECTION

- A. 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.
- B. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 EXTERIOR PAINTING SCHEDULE (BASIS OF DESIGN)

- A. Exterior Metal (previously-painted):
 - 1. Latex System:
 - a. Intermediate Coat: Latex, exterior, matching topcoat – ProIndustrial DTM Latex.
 - b. Topcoat: Latex, exterior, semi-gloss, (Gloss Level 3)- ProIndustrial DTM Latex.
- B. Exterior Metal (galvanized):
 - 1. Latex System:
 - a. Prime Coat: ProMar 200 Zero VOC.
 - b. Intermediate Coat: Latex, exterior, matching topcoat – ProIndustrial DTM Latex.
 - c. Topcoat: Latex, exterior, semi-gloss, (Gloss Level 3)- ProIndustrial DTM Latex.
- C. Ferrous Metal Substrates:
 - 1. Latex System:
 - a. Primer: Antirust Coating
 - b. Intermediate Coat: Latex, exterior, matching topcoat – ProIndustrial DTM Latex.
 - c. Topcoat: Latex, exterior, semi-gloss, (Gloss Level 5)- ProIndustrial DTM Latex

3.6 INTERIOR PAINTING SCHEDULE

- A. CMU Substrates (previously-painted):
 - 1. Primer: ProMar 200 Primer.
 - 2. Intermediate Coat: ProMar 200 Zero VOC
 - 3. Topcoat: (Gloss Level 3) - ProMar 200 Zero VOC.
- B. CMU Substrates (unpainted):
 - 1. Block Filler: Block filler, latex, interior/exterior - ProMar Interior/Exterior Semi-Gloss Block Filler and Finish.
 - 2. Intermediate Coat: Block filler, latex, interior/exterior - ProMar 200 Zero VOC

3. Topcoat: Block filler, latex, interior/exterior, (Gloss Level 1) - ProMar 200 Zero VOC.
- C. Concrete Substrates, Nontraffic Surfaces:
1. Latex System:
 - a. Prime Coat: Block Filler, Latex, Interior - ProMar Interior/Exterior Semi-Gloss Block Filler and Finish.
 - b. Intermediate Coat: Latex, interior, matching topcoat - ProMar 200 Zero VOC.
 - c. Topcoat: Latex, Interior, (Gloss Level 1) - ProMar 200 Zero VOC.
- D. Concrete Substrates, Traffic Surfaces:
1. Water-Based Clear Sealer System:
 - a. First Coat: Sealer, water based, for concrete floors.
 - b. Topcoat: Sealer, water based, for concrete floors with slip-resistant additive
- E. Gypsum Board and Plaster Substrates, including Aluminum Edge Trim:
1. Walls:
 - a. Prime Coat: ProMar 200 Zero VOC.
 - b. Intermediate Coat: ProMar 200 Zero VOC.
 - c. Topcoat: (Gloss Level 3) - ProMar 200 Zero VOC.
 2. Ceilings:
 - a. Prime Coat: ProMar 200 Zero VOC.
 - b. Intermediate Coat: ProMar 200 Zero VOC.
 - c. Topcoat: (Gloss Level 1) - ProMar 200 Zero VOC.
- F. Wood Substrates:
1. Latex System:
 - a. Prime Coat: Latex, interior, flat – ProMar 200 Zero VOC.
 - b. Topcoat: Latex, interior, flat, (Gloss Level 3) – ProMar 200 Zero VOC.
- G. Galvanized-Metal Substrates:
1. Latex over Waterborne Primer System:
 - a. Prime Coat: Primer, Galvanized, Water Based – Pro-Cryl Universal Primer.
 - b. Intermediate Coat: Latex, interior, matching topcoat – Pro Industrial Zero VOC.
 - c. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5)-Pro Industrial Zero VOC.
- H. Hollow Metal Doors and Frames (shop primed):
1. Intermediate Coat: ProIndustrial High Performance Acrylic.
 2. Topcoat: (Gloss Level 5)- ProIndustrial High Performance Acrylic.
- I. Aluminum (Not Anodized or Otherwise Coated) Substrates:
1. Latex over Waterborne Primer System:
 - a. Prime Coat: Primer, quick-dry, for aluminum – Pro-Cryl Universal Primer.
 - b. Intermediate Coat: Latex, interior, matching topcoat – Pro Industrial Zero VOC.
 - c. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5)-Pro Industrial Zero VOC.

END OF SECTION 099120

SECTION 101400

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 RELATED DOCUMENTS

- 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.

1.3 SUMMARY

- A. This Section includes the following:

- 1. Room panel signs.

1.4 DEFINITIONS

- A. ADA-ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines."

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details for signs.
 - 1. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
 - 2. Provide message list, typestyles, graphic elements, including tactile characters and Braille, and layout for each sign.
- C. Samples for Initial Selection: Manufacturer's color charts consisting of actual units or sections of units showing the full range of colors available for the following:
 - 1. Aluminum.
 - 2. Acrylic sheet.
- D. Sign Schedule: Use same designations indicated on Drawings.

- E. Qualification Data: For Installer and fabricator.
- F. Maintenance Data: For signs to include in maintenance manuals.
- G. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. 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.
- C. Source Limitations for Signs: Obtain each sign type indicated from one source from a single manufacturer.
- D. Regulatory Requirements: Comply with applicable provisions in ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

1.7 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit installation of signs in exterior locations to be performed according to manufacturers' written instructions and warranty requirements.
- B. Field Measurements: Verify recess openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.8 COORDINATION

- A. Coordinate placement of anchorage devices with templates for installing signs.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which 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 metal and polymer finishes beyond normal weathering.
 - b. Deterioration of embedded graphic image colors and sign lamination.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum Castings: ASTM B 26/B 26M, of alloy and temper recommended by sign manufacturer for casting process used and for 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, and with at least the strength and durability properties of Alloy 5005-H32.
- C. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of Alloy 6063-T5.
- D. Steel:
 - 1. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, stretcher-leveled standard of flatness.
 - 2. Steel Members Fabricated from Plate or Bar Stock: ASTM A 529/A 529M or ASTM A 572/A 572M, 42,000-psi (290-MPa) minimum yield strength.
 - 3. For steel exposed to view on completion, provide materials having flat, smooth surfaces without blemishes. Do not use materials whose surfaces exhibit pitting, seam marks, roller marks, rolled trade names, or roughness.
- E. Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), Type UVA (UV absorbing).

2.2 ROOM PANEL SIGNS

- A. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Mohawk Sign Systems. (Basis of Design).
 - 2. Best Sign Systems, Inc.
 - 3. ASI-Modulex, Inc.
 - 4. Or equal as approved by the Professional.
- B. Interior Panel Signs: Provide smooth sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch measured diagonally from corner to corner, complying with the following requirements:
 - 1. Acrylic Sheet: 0.125 inch thick.
 - 2. Edge Condition: Square cut.
 - 3. Corner Condition: Square.
 - 4. Mounting: Aluminum Framed trim.
 - a. Wall mounted with concealed anchors.
 - b. Manufacturer's standard anchors for substrates encountered.
 - 5. Color: As selected by the Professional from manufacturer's full range.
 - 6. Tactile Characters: Characters and Grade 2 Braille raised 1/32 inch (0.8 mm) above surface with contrasting colors.
- C. Panel Sign Frames:
 - 1. Extruded-Aluminum Frames: Mitered and welded.

- a. Color: As selected by the Professional from manufacturer's full range.
 - b. Profile: Square.
 - c. Corner Condition: Rounded to radius indicated.
 - d. Mounting: As indicated.
 - 1) Wall mounted with concealed anchors.
 - 2) Manufacturer's standard noncorroding anchors for substrates encountered.
- D. Tactile and Braille Sign: Manufacturer's standard process for producing text and symbols complying with ADA-ABA Accessibility Guidelines and with ICC/ANSI A117.1. Text shall be accompanied by Grade 2 Braille. Produce precisely formed characters with square-cut edges free from burrs and cut marks; Braille dots with domed or rounded shape.
 - 1. Panel Material: Opaque acrylic sheet.
 - 2. Raised-Copy Thickness: Not less than 1/32 inch.
- E. Subsurface Copy: Apply minimum 4-mil-thick vinyl copy to back face of clear acrylic sheet forming panel face to produce precisely formed opaque image. Image shall be free of rough edges.
- F. Subsurface Engraved Acrylic Sheet: Reverse-engrave back face of clear acrylic sheet. Fill resulting copy with enamel. Apply opaque background color coating over enamel-filled copy.
- G. Colored Coatings for Acrylic Sheet: For copy and background colors, provide colored coatings, including inks, dyes, and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and are UV and water resistant for five years for application intended.
 - 1. Color: As selected by the Professional from manufacturer's full range.
- H. Panel Sign Schedule:
 - 1. Provided by sign manufacturer based on room and door identifications found on the Drawings.

2.3 ACCESSORIES

- A. Anchors and Inserts: Provide nonferrous-metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion-bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

2.4 FABRICATION

- A. General: Provide manufacturer's standard signs of configurations indicated.
 - 1. Welded Connections: Comply with AWS standards for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded surfaces of welding flux and dress exposed and contact surfaces.
 - 2. Mill joints to tight, hairline fit. Form joints exposed to weather to exclude water penetration.

3. Preassemble signs in the shop to greatest extent possible. Disassemble signs only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation, in location not exposed to view after final assembly.
4. Conceal fasteners if possible; otherwise, locate fasteners where they will be inconspicuous.

2.5 FINISHES, GENERAL

- 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: 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 the 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.

2.6 ALUMINUM FINISHES

- A. Clear and Color Anodic Finish: Manufacturer's standard Class 1 clear anodic coating, 0.018 mm or thicker, over a satin (directionally textured) mechanical finish, complying with AAMA 611.

2.7 ACRYLIC SHEET FINISHES

- A. Colored Coatings for Acrylic Sheet: For copy and background and frame colors, provide colored coatings, including inks, dyes, and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and that are UV and water resistant for five years for application intended.

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 work.
- B. Verify that items, including anchor inserts, and electrical power are sized and located to accommodate signs.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Locate signs and accessories where indicated, using mounting methods of types described and complying with manufacturer's written instructions.

1. Install signs level, plumb, and at heights indicated, with sign surfaces free of distortion and other defects in appearance.
 2. Interior Wall Signs: Install signs on walls adjacent to latch side of door where applicable. Where not indicated or possible, such as double doors, install signs on nearest adjacent walls. Locate to allow approach within 3 inches of sign without encountering protruding objects or standing within swing of door.
- B. Wall-Mounted Signs: Comply with sign manufacturer's written instructions except where more stringent requirements apply. Select appropriate mounting methods from subparagraphs below.
1. Silicone-Adhesive Mounting: Attach signs to irregular, porous, or vinyl-covered surfaces.
 2. Shim Plate Mounting: Provide 1/8-inch-thick, concealed aluminum shim plates with predrilled and countersunk holes, at locations indicated, and where other mounting methods are not practicable. Attach plate with fasteners and anchors suitable for secure attachment to substrate. Attach panel signs to plate using method specified above.
 3. Mechanical Fasteners: Use nonremovable mechanical fasteners placed through predrilled holes. Attach signs with fasteners and anchors suitable for secure attachment to substrate as recommended in writing by sign manufacturer.

3.3 CLEANING AND PROTECTION

- A. After installation, clean soiled sign surfaces according to manufacturer's written instructions. Protect signs from damage until acceptance by the Client Agency.

END OF SECTION 101400

SECTION 074213

FORMED METAL WALL 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

SECTION 101416 - PLAQUES

PART 2 - GENERAL

2.1 SUMMARY

- A. Section Includes:
 - 1. Metal plaques.
- B. Related Requirements:

2.2 DEFINITIONS

- A. Accessible: In accordance with the accessibility standard.

2.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For plaques.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show plaque mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
 - 3. Show message list, typestyles, graphic elements and layout for each plaque at least half size
- C. Samples for Verification: For each type of plaque showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
 - 1. Plaques:
 - 2. Exposed Accessories: Full-size Sample
 - 3. Full-size Samples, if approved, will be returned to Contractor for use in the Project.
- D. Product Schedule: For plaques. Use same designations indicated on Drawings or specified.

2.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturer
- B. Sample Warranty: For special warranty.

2.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For plaques to include in maintenance manuals.

2.6 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer of products

PART 3 - PRODUCTS

3.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the ABA standards of the Federal agency having jurisdiction.

3.2 METAL PLAQUES

- A. Cast Plaque Cast-metal plaque with background texture, border, and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:

3.3 MANUFACTURERS

- 1. Woodland Manufacturing (Basis of Design)>
 - 2. Impact Signs
 - 3. K2Awards
 - 4. East Point Foundry
 - 5. Or equal as approved by the Professional.
- B. MATERIALS Aluminum Castings: ASTM B26/B26M, alloy and temper recommended by plaque manufacturer for casting process used and for type of use and finish indicated.
 - 1. Plaque Material: Cast aluminum
 - 2. Plaque Thickness: 0.375 inch
 - a. Integral Aluminum Finish: Clear anodized
 - 3. Background Texture: Stipple
 - 4. Integrally Cast Border Style: As indicated on Drawings
 - 5. Mounting: Rosette-head through fasteners
 - 6. Text and Typeface: EuroRoman

3.4 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of plaques, 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. Exposed Metal-Fastener Components, General:
 - a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
 - b. Fastener Heads: For nonstructural connections, use
 - c. oval countersunk
 - d. screws and bolts with tamper-resistant one-way-head slots unless otherwise indicated.
 - 4. Plaque Mounting Fasteners:
 - a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of plaque, screwed into back of plaque, or screwed into tapped lugs cast integrally into back of plaque unless otherwise indicated.
 - b. Through Fasteners: Exposed metal fasteners matching plaque finish, with type of head indicated, installed in predrilled holes.
- B. General: Provide manufacturer's standard plaques according to requirements indicated.
 - 1. Preassemble plaques in the shop to greatest extent possible. Disassemble plaques only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 - 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 - 3. Comply with AWS for recommended practices in welding and brazing. 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.
 - 4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 - 5. Provide rabbets, lugs, and tabs 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 plaque 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.

3.5 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.

3.6 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, Class I, 0.018 mm or thicker.

PART 4 - EXECUTION

4.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Verify that plaque-support surfaces are within tolerances to accommodate plaques without gaps or irregularities between backs of plaques and support surfaces unless otherwise indicated.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

4.2 INSTALLATION OF METAL PLAQUES

- A. General: Install plaques using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install plaques level, plumb, true to line, and at locations and heights indicated, with plaque surfaces free of distortion and other defects in appearance.
 - 2. Install plaques so they do not protrude or obstruct according to the accessibility standard.
 - 3. Before installation, verify that plaque surfaces are clean and free of materials or debris that would impair installation.
 - 4. 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 plaque. Remove loose debris from hole and substrate surface.
 - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place plaque in position and push until flush to surface, embedding studs in holes. Temporarily support plaque in position until adhesive fully sets.
 - b. Thin or Hollow Surfaces: Place plaque in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.
 - 2. Through Fasteners: Drill holes in substrate using predrilled holes in plaque as template. Countersink holes in plaque if required. Place plaque in position and flush to surface. Install through fasteners and tighten.

3. Brackets: Remove loose debris from substrate surface and install bracket supports in position, so that plaque is correctly located and aligned.
 4. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of plaque and of suitable quantity to support weight of plaque after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as plaque is applied and to prevent visibility of cured adhesive at plaque edges. Place plaque in position, and push to engage adhesive. Temporarily support plaque in position until adhesive fully sets.
- C. Remove and replace damaged or deformed plaques and plaques that do not comply with specified requirements. Replace plaques with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- D. Remove temporary protective coverings and strippable films as plaques are installed.
- E. On completion of installation, clean exposed surfaces of plaques according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain plaques in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101416

SECTION 101419

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:
 - 1. Dimensional characters.
 - a. Cast dimensional characters.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For 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 other installers, and accessories.
 - 3. Show message list, typestyles, graphic elements, and layout for each sign at least half size
- C. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.
 - 1. Include representative Samples of available typestyles and graphic symbols.
- 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 dimensional character.
 - 2. Exposed Accessories: Half-size Sample of each accessory type.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturer.
- B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For signs to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design sign structure and anchorage of dimensional signage mounted to canopy according to structural performance requirements.
- B. Structural Performance: Signs and supporting elements shall withstand the effects of gravity and other loads within limits and under conditions indicated.
 - 1. Uniform Wind Load: As indicated on Drawings
 - 2. Concentrated Horizontal Load: As indicated on Drawings
 - 3. Other Design Load: As indicated on Drawings
 - 4. Uniform and concentrated loads need not be assumed to act concurrently.
- C. Thermal Movements: For exterior fabricated channel dimensional characters allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces

2.2 DIMENSIONAL CHARACTERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Shield Company (Basis of Design).
 - 2. World Wide Systems
 - 3. Alphabet Signs
 - 4. Or equal as approved by the Professional.
- B. Cast Characters <SIGN-1>: Characters with uniform faces, sharp corners, and precisely formed lines and profiles, and as follows:
 - 1. Character Material: Cast aluminum
 - 2. Character Height: As indicated on Drawings
 - 3. Thickness: As indicated on Drawings
 - 4. Finishes:
 - a. Integral Aluminum Finish: Match Architect's sample
 - b. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard, in color matching Architect's sample
 - 5. Mounting: As indicated on Drawings

2.3 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, 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. Exposed Metal-Fastener Components, General:
 - a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
 - 4. 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.
 - c. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, installed in predrilled holes.

2.4 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
 - 1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 - 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 - 3. Comply with AWS for recommended practices in welding and brazing. 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.
 - 4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 - 5. Internally brace dimensional characters for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
 - 6. Provide rabbets, lugs, and tabs 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.
 - 7. 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.
- B. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.
 - 1. Stainless Steel Brackets: Factory finish brackets to match sign background finish unless otherwise indicated.

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 (0.04 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.7 STAINLESS STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - 1. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 - 2. Directional Satin Finish: No. 4.
 - 3. Dull Satin Finish: No. 6.
 - 4. Reflective, Directional Polish: No. 7.
 - 5. Mirrorlike Reflective, Nondirectional Polish: No. 8.

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.
- 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 OF DIMENSIONAL CHARACTERS

- 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. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
 4. Back Bar and Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position, so that signage is correctly located and aligned.
 5. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
 6. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.

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 101419

SECTION 102113

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 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. Solid-plastic toilet compartments configured as toilet enclosures and urinal screens.
- B. Related Requirements:
 - 1. Section 102800 "Toilet Accessories" for toilet tissue dispensers, grab bars, and similar accessories mounted on toilet compartments.

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 toilet compartments.
- B. Shop Drawings: For toilet compartments.
 - 1. Include plans, elevations, sections, details, and attachment details.
 - 2. Show locations of cutouts for compartment-mounted toilet accessories.
 - 3. Show locations of centerlines of toilet fixtures.
 - 4. Show overhead bracing locations.
- C. 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 3-inch square Samples of same thickness and material indicated for Work.
 - 2. Each type of hardware and accessory.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of toilet compartment.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For toilet compartments to include in 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 and source.
 - 1. Door Hinges: One hinge(s) with associated fasteners.
 - 2. Latch and Keeper: One latch(es) and keeper(s) with associated fasteners.
 - 3. Door Bumper: One bumper(s) with associated fasteners.
 - 4. Door Pull: One door pull(s) with associated fasteners.
 - 5. Fasteners: Twenty fasteners of each size and type.

1.8 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: 200 or less.
 - 2. Smoke-Developed Index: 450 or less.
- B. Recycled Content of Solid-Plastic Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- C. General Emissions Evaluation for Solid Plastic Components: Provide third-party certified documentation of compliance with California Department of Public Health CDPH/EHLB/Standard Method Version 1.1, 2010.
- D. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for toilet compartments designated as accessible.

2.2 SOLID-PLASTIC TOILET COMPARTMENTS

- A. Manufacturers: Subject to compliance with project requirements, provide products by one of the following:
 - 1. Scranton Products.

- a. Basis of Design: HinyHider Partitions
- 2. Knickerbocker Partition Corporation.
- 3. Metpar Corp..
- 4. Or equal as approved by the Professional.
- B. Toilet-Enclosure Style: Overhead braced, floor anchored.
- C. Urinal-Screen Style: Wall hung.
- D. Door, Panel, Screen, and Pilaster Construction: Solid, high-density polyethylene (HDPE) panel material, not less than 1 inch thick, seamless, with eased edges, and with homogenous color and pattern throughout thickness of material.
 - 1. Integral Hinges: Configure doors and pilasters to receive integral hinges.
 - 2. Color and Pattern: Fossil
 - 3. Texture: Orange peel (shallow texture).
- E. Pilaster Shoes and Sleeves (Caps): Manufacturer's standard design; polymer.
 - 1. Polymer Color and Pattern: Matching pilaster.
- F. Brackets (Fittings):
 - 1. Full-Height (Continuous) Type: Manufacturer's standard design; extruded aluminum or stainless steel.

2.3 HARDWARE AND ACCESSORIES

- A. Hardware and Accessories: Manufacturer's standard operating hardware and accessories.
 - 1. Material: Stainless steel.
 - 2. Hinges: Manufacturer's standard integral hinge for solid-plastic doors, allowing emergency access by lifting door.
 - 3. Latch and Keeper: Manufacturer's surface-mounted latch unit designed for emergency access and with combination rubber-faced door strike and keeper.
 - a. Provide units that comply with regulatory requirements for accessibility at all compartments.
 - 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.
- 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. Aluminum Extrusions: ASTM B 221.
- C. Stainless-Steel Castings: ASTM A 743.

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. Door Size and Swings: As indicated on drawings.
 - 1. Provide 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.
 - 2. Verify thickness of concrete floor slab at each anchorage location in Toilet Rooms 209 and 233.
- 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: 1/4-inch.
 - b. Panels and Walls: 3/4-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. Space fasteners equally along length of brackets.
 - c. 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. 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 102113

SECTION 102116.17

PHENOLIC-CORE SHOWER AND DRESSING 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:

- 1. Phenolic-core shower

- B. Related Requirements:

- 1. Section 055000 "Metal Fabrications" for supports that attach floor-and-ceiling-anchored compartments to the overhead structural system.
 - 2. Section 092216 "Non-Structural Metal Framing" for blocking.
 - 3. Section 102800 "Toilet, Bath, and Laundry Accessories" for accessories mounted on compartments.

1.3 COORDINATION

- A. Coordinate requirements for overhead supports, blocking, reinforcing, and other supports concealed within wall to ensure that compartments can be supported and installed as indicated.

1.4 ACTION SUBMITTALS

Action submittals are submittals requiring responsive action and return of reviewed documents to Contractor.

- A. Product Data:

- 1. Phenolic-core shower
 - a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

- B. Shop Drawings:

- 1. Include plans, elevations, sections, and attachment details.
 - 2. Show locations of cutouts for compartment-mounted accessories.
 - 3. Show locations of centerlines of drains.

4. Show overhead support or bracing locations.

C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available finishes for each type of compartment.

1. Include Samples of hardware and accessories involving material and color selection.

D. Samples for Verification: Actual sample of finished product for each type of compartment, hardware, and accessory.

1. Size: Manufacturers' standard size

E. Delegated Design Submittals: For grab bars, shower seats and accessible benches mounted on compartment panels, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include structural design calculations indicating compliance with specified structural-performance requirements.

1.5 INFORMATIONAL SUBMITTALS

A. Material Test Reports: For phenolic panel, by a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For shower and dressing compartments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

See Section 017700 "Closeout Procedures" for submission of maintenance material items.

Retain this article if required. Revise item list to suit Project.

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. Door Hinges: [One] door hinge(s) with associated fasteners.
2. Latch and Keeper: [One] latch(es) and keeper(s) with associated fasteners.
3. Clothing Hook: [One] clothing hook(s) with associated fasteners.
4. Door Bumper: [One] door bumper(s) with associated fasteners.
5. Door Pull: [One] door pull(s) with associated fasteners.
6. Fasteners: [10] fasteners of each size and type.
7. Curtain Rod: [One] curtain rod(s) with associated fasteners.
8. Curtain Hooks: [Five] curtain hooks.
9. Soap Holder: [One] soap holder(s) with associated fasteners.

1.8 QUALITY ASSURANCE

- A. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in Pennsylvania where Project is located and who is experienced in providing engineering services of the type indicated.

1.9 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of fixtures, drains, walls, columns, ceilings, and other construction contiguous with shower and dressing compartments by field measurements, and coordinate before fabrication.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain shower and dressing compartments from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E84 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.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to provide structural design calculations for grab bars, shower seats, or seats of accessible benches mounted on shower or dressing compartment panels.
- C. Structural Performance: Where grab bars, shower seats, or accessible benches are mounted on shower or dressing compartment panels, design panels to comply with the following requirements:
 - 1. Panels are able to withstand a concentrated load on grab bar, shower seat, or seat of accessible bench of at least 250 lbf (1112 N) applied at any direction and at any point, without deformation of panel.
- D. Regulatory Requirements: Comply with applicable provisions in the DOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1 for shower and dressing compartments designated as accessible.

2.3 PHENOLIC-CORE SHOWER AND DRESSING COMPARTMENTS <SC-1>

- A. Manufacturers: Subject to compliance with project requirements, provide products by one of the following:
 - 1. Knickerbocker Partition Corporation.
 - 2. Metpar Corp.
 - 3. Scranton Products.

4. Or equal as approved by the Professional

5.
a. Basis of Design: HinyHider Partitions.

B. Compartment Style: privacy type

C. Panel Construction: Solid phenolic-core panel material with melamine facing on both sides fused together during panel manufacture (not separately laminated) and with eased and polished edges. Provide minimum 1/2-inch- (13-mm-) thick panels.

D. Pilaster Construction: Match panels; 3/4-inch- (19-mm-) minimum thickness.

E. Pilaster Shoes: Formed from stainless steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness and 3 inches (76 mm) high, finished to match hardware.

F. Pilaster Sleeves (Caps): Formed from stainless steel sheet, not less than 0.031-inch (0.79-mm) nominal thickness and 3 inches (76 mm) high, finished to match hardware.

G. Brackets (Fittings):

1. Shower Compartment Brackets:

a. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel.

2. Dressing Compartment Brackets:

a. Match shower compartment brackets.

b. Stirrup Type: Ear or U-brackets; stainless steel.

c. Match toilet-compartment brackets specified in Section 102113.17 "Phenolic-Core Toilet Compartments."

H. Phenolic Compartment Finish: One color in each room.

1. Through-Color Phenolic: Manufacturer's standard solid through-color.

a. Color: As selected by Architect from manufacturer's full range

2.4 HARDWARE AND ACCESSORIES

A. Overhead Bracing: Manufacturer's standard, continuous, extruded-aluminum headrail or cap with antigrip profile; in manufacturer's standard finish.

B. Headrail with Hooks: Manufacturer's standard, continuous, extruded-aluminum headrail or cap with curtain hooks running in concealed track; with antigrip profile; in manufacturer's standard finish.

C. Curtain Rod with Hooks: Manufacturer's standard, 1-inch- (25-mm-) diameter, curtain rod with matching hooks.

D. Curtain: Flame-resistant, polyester-reinforced vinyl fabric

1. Flame Resistance: Passes NFPA 701 tests when tested by a testing and inspecting agency acceptable to authorities having jurisdiction.

2. Labeling: Identify fabrics with appropriate markings of applicable testing and inspecting agency.
3. Curtain Grommets: Two-piece, rolled-edge, rustproof, nickel-plated brass; spaced not more than 6 inches (152 mm) o.c.; machined into top hem.
4. Width: Minimum 6 inches (152 mm)
5. Length: Where curtain extends to a floor surface, size so that bottom hem clears finished floor by not more than 1 inch (25 mm) and not less than 1/2 inch (13 mm) above floor surface. Where curtains extend to a shower-receptor curb, size so that bottom hem hangs above curb line and clears curb line by not more than 1/2 inch (13 mm).
6. Color and Pattern: [As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and pattern>.

E. Soap Holder:

Retain one of two subparagraphs below.

1. Manufacturer's standard.
2. Recessed stainless steel soap dish.

F. Anchorages and Fasteners: Manufacturer's standard, exposed fasteners of stainless steel, chrome-plated steel, or solid brass, finished to match the items they are securing; with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. Use countersunk, flush-type bolt heads or otherwise make fasteners inconspicuous if exposed on opposite side of panel from hardware or accessory item. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel compatible with related materials.

2.5 MATERIALS

- A. Aluminum Castings: ASTM B26/B26M.
- B. Aluminum Extrusions: ASTM B221 (ASTM B221M).
- C. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.
- D. Stainless Steel Castings: ASTM A743/A743M.

2.6 FABRICATION

- A. Fabricate shower and dressing compartment components to sizes indicated.
- B. Floor-and-Ceiling-Anchored Compartments: Manufacturer's standard, corrosion-resistant anchoring assemblies at pilasters and walls, with leveling adjustment at tops and bottoms of pilasters. Provide shoes and sleeves (caps) at pilasters to conceal anchorage.
- C. Door Sizes and Swings: Unless otherwise indicated, provide 24-inch- (610-mm-) wide, inswinging doors for standard shower and dressing compartments, and 36-inch- (914-mm-) wide, outswinging doors with a minimum 32-inch- (813-mm-) wide, clear opening for compartments designated as accessible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, 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 OF PHENOLIC-CORE SHOWER AND DRESSING COMPARTMENTS

- A. General: Comply with manufacturer's written installation instructions. Install compartments rigid, straight, level, and plumb. Secure compartments in position with manufacturer's recommended anchoring devices.
 - 1. Clearances for Dressing Compartments: Maximum 1/2 inch (13 mm) between pilasters and panels; 1 inch (25 mm) between panels and walls.
 - 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. Floor-and-Ceiling-Anchored Compartments: Secure pilasters to supporting construction, and level, plumb, and tighten. Hang doors and adjust so doors are level and aligned with panels when doors are in closed position.
- C. Curtains: Install curtains to specified length, and verify that they hang vertically without stress points or diagonal folds.
- D. Shower Receptors: Install manufacturer's prefabricated shower receptors with drain gasket compression fit to OD of waste pipe.

3.3 ADJUSTING AND CLEANING

- A. Curtain Adjustment: After hanging curtains, test and adjust each track or rod to produce unencumbered, smooth operation. Steam and dress down curtains as required to produce crease- and wrinkle-free installation. Remove and replace curtains that are stained or soiled or that have stress points or diagonal folds.
- B. Hardware Adjustment: Clean, adjust and lubricate hardware in accordance with hardware manufacturer's written instructions for proper operation. Set hinges on inswinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on outswinging doors to return doors to fully closed position.
- C. Clean exposed surfaces of compartments after removing strippable, temporary protective covering, if any. Comply with manufacturer's written instructions for stripping of temporary protective covering and for cleaning. Replace damaged or defective items.

END OF SECTION 102116.17

SECTION 102213

WIRE MESH PARTITIONS

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. Standard-duty wire mesh partitions.
 - 2. Wire mesh ceilings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, details, and attachments to other work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

Retain "Manufacturers" Paragraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Jesco (Basis of Design)
 - 2. American Woven Wire Corporation.
 - 3. LK Goodwin
 - 4. Or equal as approved by the Professional <

2.2 MATERIALS

- A. Steel Plates, Channels, Angles, and Bars: ASTM A 36/A 36M.
- B. Steel Sheet: Cold-rolled steel sheet, ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

- C. Steel Pipe: ASTM A 53/A 53M, Schedule 40, unless another weight is indicated or required by structural loads.
- D. Steel Tubing: ASTM A 500/A 500M, cold-formed structural-steel tubing or ASTM A 513, Type 5, mandrel-drawn mechanical tubing.
- E. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with G60 (Z180) zinc (galvanized) or A60 (ZF180) zinc-iron-alloy (galvannealed) coating designation.
- F. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer, complying with MPI#79.

2.3 HEAVY-DUTY WIRE MESH PARTITIONS

- A. Mesh: 0.192-inch- (4.9-mm-) diameter steel wire woven into 2-inch (50-mm) diamond mesh or welded into 1-1/2-by-2-1/2-inch (38-mm-by-65-mm) rectangular mesh.
- B. Vertical and Horizontal Panel Framing: 1-1/2-by-3/4-by-1/8-inch (38-by-19-by-3.2-mm) cold-rolled steel channels; with holes for 3/8-inch- (9.5-mm-) diameter bolts not more than 12 inches (300 mm) o.c.
- C. Horizontal Panel Stiffeners: Two cold-rolled steel channels, 1 by 1/2 by 1/8 inch (25 by 13 by 3.2 mm), bolted or riveted toe to toe through mesh.
- D. Top Capping Bars: 3-by-1-inch (76-by-25-mm) steel channels.

Option in "Posts for 90-Degree Corners" Paragraph below allows use of an alternative material that is standard with several manufacturers.

- E. Posts for 90-Degree Corners: 1-1/2-by-1-1/2-by-1/8-inch (38-by-38-by-3.2-mm) steel angles or tubes or 2-by-2-by-0.075-inch (50-by-50-by-1.9-mm) cold-rolled steel angles or tubes with holes for 3/8-inch- (9.5-mm-) diameter bolts aligning with bolt holes in vertical framing; with 1/4-inch (6.4-mm) steel base plates.
- F. Line Posts: 3-inch-by-4.1-lb (76-mm-by-1.9-kg) or 3-1/2-by-1-1/4-by-1/8-inch (89-by-32-by-3.2-mm) steel channels; with 1/4-inch (6.4-mm) steel base plates.
- G. ThreeWay Intersection Posts: 2-by-2-by-0.075-inch (50-by-50-by-1.9-mm) steel tubes, with holes for 3/8-inch- (9.5-mm-) diameter bolts aligned for bolting to adjacent panels; with 1/4-inch (6.4-mm) steel base plates.
- H. Floor Shoes: Metal, not less than 2 inches (50 mm) high; sized to suit vertical framing, drilled for attachment to floor, and with set screws for leveling adjustment.
- I. Sliding Doors: Fabricated from same mesh as partitions, with framing fabricated from 1-1/2-by-3/4-by-1/8-inch (38-by-19-by-3.2-mm) steel channels, banded with 1-1/2-by-1/8-inch (38-by-3.2-mm) flat steel bar cover plates on four sides.
 - 1. Hardware: Two, four-wheel roller-bearing carriers, box track, and bottom guide channel for each door.
 - 2. Cylinder Lock: Mortise type with manufacturer's standard cylinder operated by key outside and lever inside; mounted in lower section of door.
- J. Accessories:

"Sheet Metal Base" Subparagraph below is for wainscot panels.

1. Sheet Metal Base: 0.060-inch- (1.5-mm-) thick, steel sheet.
2. Adjustable Filler Panels: 0.060-inch- (1.5-mm-) thick steel sheet, capable of filling openings from 2 to 12 inches (50 to 300 mm).

K. Finish: Powder-coated finish unless otherwise indicated.

1. Color: Vista Green

2.4 WIRE MESH CEILINGS

- A. Mesh, Framing, and Stiffeners: Fabricated from same mesh and framing as wire mesh partition panels.
- B. Perimeter Partition Supports: 1-1/2-by-1-1/2-by-1/8-inch (38-by-38-by-3.2-mm) steel angle, with holes for 1/4-inch- (6-mm-) diameter bolts aligned for bolting to top of wire mesh partitions and to sides of wire mesh ceiling panels.
- C. Wall Supports: 1-1/2-by-1-1/2-by-1/8-inch (38-by-38-by-3.2-mm) steel angle punched for attachment to wall and wire mesh ceiling panels.
- D. Intermediate Supports: Steel I-beams or rectangular tubes, as recommended by manufacturer.
- E. Intermediate Support Posts: [2-by-2-by-1/8-inch (50-by-50-by-3.2-mm)
- F. Finishes: Match adjacent wire mesh partitions.

2.5 FABRICATION

- A. General: Fabricate wire mesh items from components of sizes not less than those indicated. Use larger-sized components as recommended by wire mesh item manufacturer. Furnish bolts, hardware, and accessories required for complete installation with manufacturer's standard finishes.
 1. Fabricate wire mesh items to be readily disassembled.

Retain one of four options in "Welding" Subparagraph below; options are listed with best appearance and highest cost first.

2. Welding: Weld corner joints of framing and grind smooth, leaving no evidence of joint
- B. Heavy-Duty Wire Mesh Partitions: Fabricate wire mesh partitions with cutouts for pipes, ducts, beams, and other items indicated. Finish edges of cutouts to provide a neat, protective edge.
 1. Mesh: Weld mesh to framing.
 2. Framing: Fabricate framing with mortise and tenon corner construction.
 - a. Provide horizontal stiffeners as indicated or, if not indicated, as required by panel height and as recommended by wire mesh partition manufacturer. Weld horizontal stiffeners to vertical framing.
 3. Fabricate wire mesh partitions with bottom horizontal framing flush with finished floor.
 4. Doors: Align bottom of door with bottom of adjacent panels.

- a. For doors that do not extend full height of partition, provide transom over door, fabricated from same mesh and framing as partition panels.
- 5. Hardware Preparation: Mortise, reinforce, drill, and tap doors and framing as required to install hardware.
- C. Wire Mesh Ceilings: Fabricate wire mesh partitions with cutouts for pipes, ducts, beams, and other items indicated. Finish edges of cutouts to provide a neat, protective edge.
 - 1. Mesh: Weldmesh to framing.
 - 2. Framing: Fabricate framing with welded corner construction.
 - a. Provide stiffeners as indicated or, if not indicated, as required by panel span and as recommended by wire mesh ceiling manufacturer. Weld stiffeners to framing.

2.6 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.
- B. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning." Retain "Shop Priming," "Enamel Finish," or "Powder-Coat Finish" Paragraph below or insert another. Paint finish options for wire mesh units vary widely. For exact finish, insert names of coating manufacturers and products.
- C. Shop Priming: Apply shop primer to uncoated surfaces of wire mesh units unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
- D. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard baked-on powder-coat finish, suitable for use indicated, with a minimum dry film thickness of [2 mils (0.05 mm)] <Insert dimension>.
 - 1. Color and Gloss: Match Architect's sample

PART 3 - EXECUTION

3.1 WIRE MESH PARTITIONS ERECTION

- A. Anchor wire mesh partitions to floor with 3/8-inch- (9.5-mm-) diameter post installed expansion anchors at 12 inches (300 mm) o.c. through anchor clips located at each post and corner. Shim anchor clips as required to achieve level and plumb installation.
- B. Anchor wire mesh partitions to walls at 12 inches (305 mm) o.c. through back corner panel framing.
- C. Secure top capping bars to top framing channels with 1/4-inch- (6-mm-) diameter "U" bolts spaced not more than 28 inches (700 mm) o.c.
- D. Provide line posts at locations indicated.

- E. Provide seismic supports and bracing as indicated or, if not indicated, as recommended by manufacturer and as required for stability, extending and fastening members to supporting structure.
- F. Install service windows complete with window hardware.
- G. Weld or bolt sheet metal bases to [wire mesh partitions] [and] [doors] [where indicated].

3.2 WIRE MESH CEILINGS ERECTION

- A. Anchor wall support angle to walls at 12 inches (300 mm) o.c.
- B. Attach wire mesh ceiling panels to wall support angles with bolts at 12 inches (305 mm) o.c.
- C. Attach wire mesh ceiling panels to wire mesh partitions with slotted angles bolted to sides of ceiling panels and to top of partitions at 12 inches (305 mm) o.c.
- D. Attach wire mesh ceiling panels to intermediate supports as recommended by manufacturer.

3.3 ADJUSTING AND CLEANING

- A. Adjust doors to operate smoothly and easily, without binding or warping. Adjust hardware to function smoothly. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 10605

SECTION 102600

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 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. Corner guards.

1.4 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.
- 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 Initial Selection: For each type of impact-resistant wall-protection unit indicated, in each color and texture specified.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of wall and door protection product to include in maintenance manuals.
 - 1. Include precautions against using cleaning materials and methods that may be detrimental to finishes and performance.

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. Corner-Guards: Full-size stainless steel guards of maximum length equal to five percent of each type, color, and texture of cover installed, but no fewer than one 8-foot long unit and one 10-foot long unit.
 - 2. Mounting and Accessory Components: Amounts proportional to the quantities of extra materials. Package mounting and accessory components with each extra material.

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 65 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 65 deg F.
 - a. Store wall and door protection materials in a flat, 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, 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 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 CORNER GUARDS

- A. Flush-Mounted, Plastic-Cover Corner Guards <CG-1>: Manufacturer's standard assembly consisting of snap-on, resilient plastic cover that is flush with adjacent wall surface, installed over retainer; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition; full wall height.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include-the following:
 - a. Construction Specialties, Inc.(Basis of Design)
 - b. Inpro Corporation.
 - c. Koroseal Interior Products.
 - d. Pawling Corporation.
 - e. Or equal as approved by the Professional.
 - 2. Cover: Extruded rigid plastic, minimum 0.100-inch (2.5-mm) wall thickness;
 - a. Profile: Nominal 3-inch- (75-mm-) long leg and 1/4-inch (6-mm) corner radius
 - b. Height: 8 feet (2.4 m)
 - c. Color and Texture: Pearl Grey

2.4 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. Fasteners: Stainless steel metal screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.
- C. Adhesive: Mildew-resistant, nonstaining adhesive, for use with specific protection material and substrate application; as recommended in writing by manufacturer of wall protection products.
 - 1. Adhesive shall have VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 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.
- D. Fabricate corner guards in single lengths without seams.

2.6 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 and door 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 and door 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 and door protection.
- B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

- A. Installation Quality: Install wall and door 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 and door protection in locations and at mounting heights indicated on Drawings. If not indicated on Drawings, install at heights indicated below:
 - 1. Corner Guards: Bottom edge of corner guard to be 4 inches above finished floor.
- C. Accessories: Provide splices, mounting hardware, anchors, trim, joint moldings, and other accessories required for a complete installation.
 - 1. Provide anchoring devices and suitable locations to withstand imposed loads.
- D. Abuse-Resistant Wall Covering: Install top and edge moldings, corners, and divider bars as required for a complete installation.

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 102600

SECTION 102800
TOILET 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 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. Public-use washroom accessories.
 - 2. Custodial accessories.
- B. Related Requirements:
 - 1. Section 087100 "Door Hardware" for wall-mounted hat and coat hooks (Accessory Type K).
 - 2. Section 102113 "Plastic Toilet Compartments" for hooks mounted to toilet compartment doors.

1.4 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.

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.
 - 2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
 - 3. Include electrical characteristics.

- B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
 - 1. Identify locations using room designations indicated.

1.6 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer's special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For accessories to include in maintenance manuals.

1.8 WARRANTY

- A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, visible silver spoilage defects.
 - 2. Warranty Period: 10 years from date of Substantial Completion.

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.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
- B. Toilet Tissue (Multi-Roll) Dispenser - Accessory Type E:
 - 1. Kimberly Clark (Basis of Design)
 - a. Model 09551
 - 2. American Specialties
 - 3. Georgia Pacific
 - 4. Or equal as approved by the Professional.
- C. Paper Towel (Roll) Dispenser -Accessory Type H:
 - 1. Manufacturer: Kimberly Clark (Basis of Design)
 - a. Model: 09765.
 - 2. American Specialties
 - 3. Georgia Pacific
 - 4. Or equal as approved by the Professional.
- D. Soap Dispenser (Accessory Type N):
 - 1. American Specialties (Basis of Design)
 - a. Model: 0347

2. Kimberly Clark
3. Bobrick Washroom Equipment Inc
4. Or equal as approved by the Professional.

E. Grab Bar (Accessory Type D):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Specialties, Inc.(Basis of Design)
 - b. Bobrick Washroom Equipment, Inc.
 - c. Bradley Corporation.
 - d. Or equal as approved by the Professional
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: 1-1/2 inches.
5. Configuration, Length, and Locations: As indicated on Drawings.

F. Sanitary-Napkin Disposal Unit (Accessory Type M):

1. American Specialties, Inc (Basis of Design)
2. Bobrick Washroom Equipment, Inc.(Basis of Design)
3. Evogen
4. Or equal as approved by Professional
5. Basis of Design Product: 0852.
6. Mounting: Surface mounted.
7. Door or Cover: Self-closing, disposal-opening cover.
8. Material and Finish: Stainless steel, No. 4 finish (satin).
9. Location: Within each stall in Toilet Rooms 116 and 217.
- 10.

G. Mirror Unit (Accessory Type L):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Specialties, Inc.(Basis of Design)
 - 1) Model: 0600
 - b. Bobrick Washroom Equipment, Inc.
 - c. Bradley Corporation.
 - d. Or equal as approved by the Professional
2. Frame: Stainless-steel channel.
 - a. Corners: Mitered and mechanically interlocked.
 - b. Hangers: Product rigid, tamper- and theft-resistant installation, using method indicated below.
 - c. Wall bracket of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.
3. Size: 24 inches wide and 36 inches tall.

2.3 CUSTODIAL ACCESSORIES

A. Mop and Broom Holder with Integral Shelf:

1. Manufacturers:
 - a. American Specialties, Inc.(Basis of Design)
 - b. Regency
 - c. Bobrick
 - d. Or equal as approved by the Professional
 - e. (Basis of Design) Model: 1308-3
 - 1) Description: Unit with shelf, hooks, and mop holders beneath shelf.
 - 2) Length: 34 inches, minimum.
 - 3) Shelf Depth: 6 inches.
 - 4) Shelf Thickness: 3/4-inches, with edges hemmed.
 - 5) Hooks: Three.
 - 6) Mop/Broom Holders: Two, spring-loaded, rubber hat, cam type.
 - 7) Material and Finish: Stainless steel, No. 4 finish (satin).
 - a) Shelf, back panel, and mop strip: Not less than 18-gauge thick stainless steel.
 - b) Hooks: Not less than 14-gauge thick stainless steel.
 - 8) Location: Room 107

2.4 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch minimum nominal thickness unless otherwise indicated.
- B. Steel Sheet: ASTM A 1008, Designation CS (cold rolled, commercial steel), 0.036-inch minimum nominal thickness.
- C. Galvanized-Steel Sheet: ASTM A 653, with G60 hot-dip zinc coating.
- D. Galvanized-Steel Mounting Devices: ASTM A 153, hot-dip galvanized after fabrication.
- E. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
- F. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.5 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 PREPARATION

- A. Provide Owner with required quantity of each type of toilet accessory which they will order from their vendor. Coordinate delivery of Owner-provided accessories to Project Area.

3.2 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.
- C. Sanitary Napkin Disposal Unit: Install on toilet partition specified in another Division 10 Section.

3.3 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written instructions.

END OF SECTION 102800

SECTION 104413

FIRE EXTINGUISHER 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 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. Cabinets for portable fire extinguishers.
 - 2. Fire extinguishers are specified in another Division 10 Section.

1.4 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.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 FIRE-PROTECTION CABINET (FEC)

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - 1. J.L. Industries, a division of the Activar Construction Products Group.(Basis of Design)
 - 2. Larsen's Manufacturing Company.
 - 3. Potter-Roemer LLC.
 - 4. Or equal as approved by the Professional
- B. Cabinet Type: Suitable for fire extinguisher.

- C. Cabinet Construction: Nonrated.
- D. Cabinet Material: Stainless steel sheet.
- E. Semi-recessed 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. Rolled-Edge Trim: 2-1/2-inch backbend depth.
- F. Cabinet Trim Material: Stainless steel sheet.
- G. Door Material: Stainless steel sheet.
- H. Door Style: Fully glazed panel with frame.
- I. Door Glazing: Tempered float glass (clear).
- J. 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.
- K. Accessories:
 - 1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
 - 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: Silk-screened or Pressure-sensitive vinyl letters.
 - 3) Lettering Color: Red.
 - 4) Orientation: Vertical.
- L. Materials:
 - 1. Stainless Steel: ASTM A 666, Type 304.
 - a. Finish: No. 4 directional satin finish.
 - 2. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.2 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.

- 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.

2.3 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.
- 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 indicated on drawings and at height indicated below:
 - 1. Fire-Protection Cabinets: 54 inches above finished floor to top of cabinet.
- 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 according to Manufacturer's instructions.

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 104413

SECTION 104416
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 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 portable, hand-carried fire extinguishers.

1.4 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.

1.5 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.7 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.8 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: Five 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.
 - 1. Provide fire extinguishers approved, listed, and labeled by FM Global.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - 1. J.L. Industries, a division of the Activar Construction Products Group. (Basis of Design)
 - 2. Larsen's Manufacturing Company.
 - 3. Potter-Roemer LLC.
 - 4. Or equal as approved by the Professional
- B. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet indicated.
 - 1. Valves: Manufacturer's standard.
 - 2. Handles and Levers: Manufacturer's standard.
 - 3. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.
- C. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 2-A:10-B:C, 20-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

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 in fire extinguisher cabinets in locations indicated on drawings and in compliance with requirements of authorities having jurisdiction.

END OF SECTION 104416

SECTION 105113

METAL 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. Welded lockers.
 - 2. Locker benches.

1.3 ACTION SUBMITTALS

- A. Product data.
- B. Shop Drawings: Include plans, elevations, sections, details, attachments to other work, and locker identification system and numbering sequence.
- C. Samples: For each color specified.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.
 - 1. Warranty Period for Welded Metal Lockers: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Requirements: For lockers indicated to be accessible, comply with applicable provisions in ICC A117.1

2.2 WELDED ATHLETIC LOCKERS <LCK-1>

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - 1. ASI Storage Solutions. (Basis of Design).
 - 2. StrongHold
 - 3. Lyon
 - 4. Or equal as approved by the Professional.
- B. Size: 24"D x 36"W x 72"H
- C. Solid-Metal Doors: Fabricated from 0.090-inch (2.28-mm) nominal-thickness expanded metal; welded to 0.105-inch (2.66-mm) nominal-thickness steel angle frame; with 0.090-inch (2.28-mm) nominal-thickness, steel sheet lock panel backed by 0.060-inch (1.52-mm) nominal-thickness, steel sheet retainer welded to door frame.
- D. Body: Assembled by welding body components together. Fabricate from unperforated steel sheet with thicknesses as follows:
 - 1. Tops and Bottoms: 0.060-inch (1.52-mm) nominal thickness, with single bend at edges.
 - 2. Backs: 0.048-inch (1.21-mm) nominal thickness.
 - 3. Shelves: 0.060-inch (1.52-mm) nominal thickness, with double bend at front and single bend at sides and back.
- E. Unperforated Sides: Fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet.
- F. Frames: Channel formed; fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet or 0.097-inch (2.45-mm) nominal-thickness steel angles; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames.
- G. Reinforced Bottoms: Structural channels, formed from [0.060-inch (1.52-mm)] [0.075-inch (1.90-mm)] nominal-thickness steel sheet; welded to front and rear of side-panel frames.
- H. Hinges:
 - 1. Knuckle Hinges: Steel, full loop, five or seven knuckles, tight pin; minimum 2 inches (51 mm) high. Provide no fewer than three hinges for each door more than 42 inches (1067 mm) high.
 - 2. Continuous Hinges: Manufacturer's standard, steel; side or top mounted as required by locker configuration.
 - 3. Hinges: Manufacturer's standard, steel, continuous or knuckle type.
- I. Recessed Door Handle and Latch: Stainless-steel cup with integral door pull, recessed so locking device does not protrude beyond door face; pry and vandal resistant.

1. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks, built-in cylinder locks, or padlocks; positive automatic latching and prelocking.
 - a. Latch Hooks: Equip doors 48 inches (1219 mm) and higher with three latch hooks and doors less than 48 inches (1219 mm) high with two latch hooks; fabricated from 0.120-inch (3.04-mm) nominal-thickness steel sheet; welded to full-height door strikes; with resilient silencer on each latch hook.
 - b. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism.
2. Single-Point Latching: Nonmoving latch hook with steel padlock loop that projects through recessed cup and is finished to match metal locker body
 - a. Latch Hook: Equip each door with one latch hook, fabricated from 0.120-inch (3.04-mm) nominal-thickness steel sheet; welded midway up full-height door strike; with resilient silencer.
- J. Projecting Turn-Handle and Latch: Steel handle welded to manufacturer's standard, three-point, cremone-type latching mechanism consisting of steel rods or bars that engage locker frame at top and bottom of door, and center latch that engages strike jamb; with steel padlock loop.
- K. Door Handle and Latch for Box Lockers: Stainless-steel strike plate with integral pull; with steel padlock loop that projects through metal locker door.
- L. Locks: Combination padlocks
- M. Identification Plates: Manufacturer's standard, etched, embossed, or stamped aluminum plates, with numbers and letters at least 3/8 inch (9 mm) high.
- N. Hooks: Manufacturer's standard ball-pointed type, aluminum or steel; zinc plated.
- O. Coat Rods: Manufacturer's standard.
- P. Continuous Zee Base: 4 inches (102 mm) high; fabricated from 0.075-inch (1.90-mm) nominal-thickness steel sheet.
- Q. Continuous Sloping Tops: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet, with a pitch of approximately 20 degrees.
 1. Closures: Vertical
- R. Recess Trim: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.
- S. Filler Panels: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.
- T. Boxed End Panels: Fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet.
- U. Materials:
 1. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with A60 (ZF180) zinc-iron, alloy (galvannealed) coating designation.
 2. Expanded Metal: ASTM F 1267, Type II (flattened), Class I, 3/4-inch (19-mm) steel mesh, with at least 70 percent open area.
- V. Finish: powder coat.
 1. Color: Charcoal

2.3 LOCKS

- A. Combination Padlocks: Key-controlled, three-number dialing combination locks; capable of five combination changes Provided by Owner

2.4 LOCKER BENCHES

- A. Provide bench units with overall assembly height of [17-1/2 inches (445 mm)] <Insert dimension>.
- B. Bench Tops: Manufacturer's standard one-piece units, with rounded corners and edges.
 - 1. Size: Minimum 9-1/2 inches wide by 1-1/4 inches thick except provide minimum 20-inch- (508-mm-) wide tops where accessible benches are indicated].
 - 2. Plastic Laminate- Color Neo Walnut
- C. Fixed Pedestals: Manufacturer's standard tubular steel supports, with predrilled fastener holes for attaching bench top and anchoring to floor, complete with fasteners and anchors.
 - 1. Color: Match metal lockers
- D. Materials:
 - 1. Stainless Steel: ASTM A 666, Type 304.
 - 2. Steel Tube: ASTM A 500/A 500 M, cold rolled.
 - 3. Particleboard: ANSI A208.1, Grade M-2.

2.5 FABRICATION

- A. Fabricate metal lockers square, rigid, without warp, and with metal faces flat and free of dents or distortion. Make exposed metal edges safe to touch and free of sharp edges and burrs.
- B. Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments. Factory weld frame members of each metal locker together to form a rigid, one-piece assembly.
- C. Equipment: Provide each locker with an identification plate and the following equipment:
 - 1. Single-Tier Units: Shelf, one double-prong ceiling hook, and two single-prong wall hooks.
 - 2. Coat Rods: each compartment of each locker
- D. Welded Construction: Factory preassemble metal lockers by welding all joints, seams, and connections; with no bolts, nuts, screws, or rivets used in assembly of main locker groups. Factory weld main locker groups into one-piece structures. Grind exposed welds flush.
- E. Accessible Lockers: Fabricate as follows:
 - 1. Locate bottom shelf no lower than 15 inches (381 mm) above the floor.
 - 2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches (1219 mm) above the floor.
- F. Continuous Base: Formed into channel or zee profile for stiffness, and fabricated in lengths as long as practical to enclose base and base ends of metal lockers; finished to match lockers.

- G. Continuous Sloping Tops: Fabricated in lengths as long as practical, without visible fasteners at splice locations; finished to match lockers.
- H. Individual Sloping Tops: Fabricated in width to fit one locker frame in lieu of flat locker tops; with integral back; finished to match lockers. Provide wedge-shaped divider panels between lockers.
- I. Recess Trim: Fabricated with minimum 2-1/2-inch (64-mm) face width and in lengths as long as practical; finished to match lockers.
- J. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip-joint filler angle formed to receive filler panel.
- K. Boxed End Panels: Fabricated with 1-inch- (25-mm-) wide edge dimension, and designed for concealing fasteners and holes at exposed ends of nonrecessed metal lockers; finished to match lockers.
- L. Finished End Panels: Designed for concealing unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.
- M. Center Dividers: Full-depth, vertical partitions between bottom and shelf; finished to match lockers.

PART 3 - EXECUTION

3.1 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 (910 mm) 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 of lockers and to floor.
 - 3. Anchor back-to-back metal lockers to floor.
- B. Welded Lockers: Connect groups together with standard fasteners, with no exposed fasteners on face frames.
- C. Trim: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.
 - 1. Attach recess trim to recessed metal lockers with concealed clips.
 - 2. Attach filler panels with concealed fasteners.
 - 3. Attach sloping-top units to metal lockers, with closures at exposed ends.
- D. Fixed Locker Benches: Provide no fewer than two pedestals for each bench, uniformly spaced not more than 72 inches (1830 mm) apart.

END OF SECTION 105113

SECTION 111323
PORTABLE 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 RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

- 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 portable loading dock lifts (scissors lifts).
- B. Related Requirements:

Retain subparagraph below to cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections.

- 1. Section 111319 "Stationary Loading Dock Equipment" for stationary dock lifts (scissor lifts).

1.4 DEFINITIONS

Definition in paragraph below is from MH 30.1 and specifically applies to dock levelers.

- A. Operating Range: Maximum amount of travel above and below the loading dock level.

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.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For portable 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 of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For portable dock equipment, to include in operation and maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

PART 2 - PRODUCTS

2.1 PORTABLE LOADING DOCK LIFTS (SCISSOR LIFTS) <LD-1>

- A. General: Portable, scissors-type, single-leg, hydraulic dock lift of capacity, size, and construction indicated; complete with controls, safety devices, and accessories required.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, following:
 1. Autoquip (Basis of Design).
 2. Ballymore
 3. Southwith
 4. Or equal as approved by the Professional
- 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. Standard: MH 29.1.
- E. Rated Capacity: Lifting capacity of not less than 4000 lb
- F. Platform: Nonskid, safety-tread steel deck plate.
 1. Platform Size: 60 inches wide by 84 inches (1829 mm) long
 2. Platform Guarding: Bevel toe guards
 3. Removable Guard Rails: Provide steel guard rails on two sides of platform with a single, removable chain across each end. Provide guard rails not less than 39 inches (991 mm) high with midrail and 4-inch- (102-mm-) high, kick plate at bottom.
- G. Bridge: Nonskid, safety-tread steelplate.

1. Hinged Bridge: Hinged, throw-over bridge bolted to full-length, heavy-duty, piano-type hinge welded to toe guard at end of platform. Provide bridge complete with heavy-duty lifting chains. Chamfer edge of bridge to minimize obstructing wheels of material-handling vehicles.
 2. Size: 18 inches (457 mm) long by 60 inches (1524 mm) wide
- H. Function: Dock lifts shall compensate for differences in height between truck bed and loading platform.
1. Vertical Travel: Maximum of 55.5 inches from a lowered height of 4.5 inches for a total raised height of 60 inches
 2. Hinged Throw-over Bridge Operation: Manual
- I. Hydraulic Operating System: Self-contained, electric, hydraulic power unit for raising and lowering lift; of size, type, and operation needed for capacity of lift indicated; controlled from a remotely located push-button station.
1. Power Unit: Consisting of continuous-duty motor, high-pressure gear pump, valve manifold, oil-line filters, and oil reservoir.0
 - a. Equip manifold with relief valve, check valve, pressure-compensated flow-control valve, and solenoid valve and with provisions for lowering lift manually if power fails.
 - b. Equip reservoir, valve manifold, and pressure line with oil-line filters.
 2. Cylinders: Equip lift with not less than two heavy-duty, high-pressure, hydraulic, ram-type cylinders. Rams shall be manufacturer's standard, either direct-displacement plunger or rod-and-piston type with positive internal stops. Cylinder rods shall be chrome plated and polished.
 - a. Rate of Descent Protection: Pressure-compensated flow control or hydraulic velocity fuse to limit down speed for each cylinder.
 3. Remote-Control Station: Multibutton control station of the constant-pressure type with UP and DOWN push buttons. Controller shall consist of magnetic motor starter with three-pole adjustable overloads and 24-V control transformer with 4-A, fused secondary prewired to terminal strips and enclosed in NEMA ICS 6, [Type 12] <Insert type> box.
 - a. Upper-Travel-Limit Switch: Equip unit with manufacturer's standard, adjustable, upper-travel-limit switch.
- J. Construction: Fabricate lift from structural-steel shapes rigidly welded and reinforced for maximum strength, safety, and stability. Design assembly to withstand deformation during both operating and stored phases of service. Provide mounting brackets and removable lifting eyes for ease of installation.
1. Scissors Mechanism: Fabricate leg members from heavy steel-formed tube or plate members to provide maximum strength and rigidity.
 2. Scissors Configuration: Single leg
 3. Bearings: Pivot points with permanently lubricated antifriction bushings or sealed ball-bearings for minimum maintenance.
 4. Maintenance Leg: Removable, safety maintenance leg or hinged, safety maintenance bars.
- K. 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 (380).
3. Steel Tubing: ASTM A500/A500M, cold formed.

2.2 FINISH REQUIREMENTS

- A. Baked-on Factory Finish: Provide unless otherwise indicated. Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat in manufacturer's standard color.
 1. 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 portable dock equipment to verify actual locations of connections before equipment installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Install portable dock equipment as required for a complete installation.

3.3 ADJUSTING

- A. Adjust portable dock equipment to function smoothly and safely, and lubricate as recommended by manufacturer.
- B. Test lifts for vertical travel and adjust to maintain operating range indicated.
- C. After completing installation of exposed, factory-finished portable dock equipment, inspect exposed finishes and repair damaged finishes.

3.4 MAINTENANCE SERVICE

- A. Beginning at Substantial Completion, maintenance service shall include sixmonths' full maintenance by manufacturer's authorized service representative. Include annual preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper portable dock equipment operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain portable dock equipment.

END OF SECTION 111323

SECTION 122413

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. Motor operated roller shades @ Multipurpose
 - 2. Manual operated roller shades, except at Multipurpose.

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 project specific installation details for roller shades, including shadeband materials, their orientation to rollers, their seam and batten locations and relationship to adjacent construction.
 - 1. Indicate locations of joints in exposed closure panels.
- C. Samples for Initial Selection: For each type and color of shadeband material.
 - 1. Include Samples of accessories involving color selection.
 - 2. Shadeband Material: Not less than 12 inches square. Mark inside face of material if applicable.
 - 3. Installation Accessories: Finishes applied to metal substrate, 6 inches long, minimum.
- D. Roller-Shade Schedule: Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

- B. Product Certificates: For each type of shadeband material, signed by product manufacturer.
- C. Product Test Reports: For each type of shadeband material, for tests performed 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. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. MechoSystems. (Basis of Design)
 - 2. Hunter Douglas
 - 3. Legrand
 - 4. Or equal as approved by the Professional
- B. Source Limitations: Obtain roller shades from single source from single manufacturer.

2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

- A. 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.
2. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller-shade weight and lifting heavy roller shades.
- a. Provide for shadebands that weigh more than 10 lb or for shades as recommended by manufacturer, whichever criteria are more stringent.

2.3 TOP DOWN ROLLER SHADES

- A. Motorized Operating Mechanisms: Provide factory-assembled shade-operator systems of size and capacity and with features, characteristics, and accessories suitable for conditions indicated and recommended by manufacturer for use with shades indicated.
- 1. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. IQ2+ Encoded Electric Motors for operating roller shades.
 - a. Electrical Characteristics: Single phase, 24 Hz.
 - 3. Remote Controls Individual wall-switch control stations.
- B. 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 Mounting Configuration: Single roller
 - 2. Roller Drive-End Location: Right side of inside face of shade
 - 3. Direction of Shadeband Roll: Regular, from back of roller
 - 4. Shadeband-to-Roller Attachment: Manufacturer's standard method Removable spline fitting integral channel in tube
- C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.

2.3 BOTTOM UP MOTOR CONTROL SYSTEMS

- A. FTS Control System: Specifications and design of shade motors and motor control system are based on the Fabric Tension System by MechoShade Systems, Inc.
- Motor Control System:
- a. FTS Control Module: synchronizing relays in 10" X 8" X 6" electrical control enclosure. FTS module must be accessible and mounted below plane of shade in closed position. One FTS module required per shade.
 - b. Control system components shall provide appropriate (spike and brown out) over-current protection (+/- 10 percent of line voltage) for each of the four individual motor circuits and shall be rated by UL or ETL as a recognized component of this system and tested as an integrated system.

Wall Switches:

- c. Three-button architectural flush mounted switches with metal cover plate and no exposed fasteners.

- d. Connect local wall switches to control system components via low voltage (12V DC) 4-conductor modular cable equipped with RJ-11 type connectors supplied, installed and certified under Division 16 - Electrical.

Mecho Network Control (Mecho Net Interface)

- e. The system shall have the capability of two-way digital communication with the EDU's over a common backbone.
- f. Each EDU shall possess 8 addresses capable of being employed for various levels of group control. These addresses shall be configurable via a handheld configurator and/or a PC controller. A 9th unique address shall enable the EDU(s) to be independently controlled and configured over the network via a handheld configurator and/or a PC controller.
- g. Low Voltage Communication Network Implementation.
- h. The low voltage network shall employ a bus topology with daisy chained network connections between nodes over a CAT5 cable (4 UTP) or over a 2 UTP cable employing at least 1 pair at 16 AWG for power and 1 pair at 22 AWG for data.
- i. The low voltage network (+/- 13VDC) shall be powered by the nodes attached to it. These nodes could be line voltage powered EDU's attached to 120 VAC or 230 VAC. Alternatively, low voltage nodes shall be powered typically by a centralized low voltage power supply. If a CAT5 network cable is employed and the node draws less than 1W then the node may be powered supplied by an associated line voltage EDU. Network Capacity: 4000 ft max, 250 nodes max. The number and size of a centralized DC supply shall vary depending upon the network requirements.

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-Blocking Fabric: Opaque fabric, stain and fade resistant.
 - 1. Source: Roller-shade manufacturer.
 - a. Basis of Design: Classic Blackout, 700 Series.
 - 2. Type: Fiberglass textile with PVC film bonded to both sides.
 - 3. Orientation on Shadeband: Up the bolt.
 - 4. Features: Washable.
 - 5. Colors:
 - a. Interior (room side): Black.
 - b. Exterior: White.
 - 6. Seams: As indicated on drawings
- C. Shade Fabrication
 - B. Fabricate shade cloth to hang flat without buckling or distortion. Fabricate with heat-sealed trimmed edges to hang straight without curling or raveling. Fabricate unguided shadecloth to roll true and straight without shifting sideways more than 1/8 inch (3.18 mm) in either direction per 8 feet (2438 mm) of shade height due to warp distortion or weave design.
 - C. Provide battens in standard shades as required to assure proper tracking and uniform rolling of the shade bands. Contractor shall be responsible for assuring the width-to-height (W:H) ratios shall not exceed manufacturer's standards or, in absence of such standards, shall be

responsible for establishing appropriate standards to assure proper tracking and rolling of the shadecloth within specified standards. Battens shall be roll-formed stainless steel or tempered steel, as required.

- D. For railroaded shade bands, provide seams in railroaded multi-width shade bands as required to meet size requirements and in accordance with seam alignment as acceptable to Architect. Seams shall be properly located. Furnish battens in place of plain seams when the width, height, or weight of the shade exceeds manufacturer's standards. In absence of such standards, assure proper use of seams or battens as required to, and assure the proper tracking of the railroaded multi-width shade bands
- E. Provide battens for railroaded shades when width-to-height (W:H) ratios meet or exceed manufacturer's standards. In absence of manufacturer's standards, be responsible for proper use and placement of battens to assure proper tracking and roll of shade bands.

2.5 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-Blocking Fabric: Opaque fabric, stain and fade resistant.
 - 1. Source: Roller-shade manufacturer.
 - a. Basis of Design: Classic Blackout, 700 Series.
 - 2. Type: Fiberglass textile with PVC film bonded to both sides.
 - 3. Orientation on Shadeband: Up the bolt.
 - 4. Features: Washable.
 - 5. Colors:
 - a. Interior (room side): Black.
 - b. Exterior: White.
 - 6. Seams: As indicated on drawings

2.6 INSTALLATION ACCESSORIES

- A. Catch pin.

2.7 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. 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.
 - 1. Railroaded Materials: Railroad material where material roll width is less than the required width of shadeband. 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.

2. Hem bar for light-filtering shades: Steel or extruded aluminum bar, enclosed in sealed pocket of shadeband material.

2.8 ROLLER SHADE SCHEDULE

- A. Shade Assembly RS-1:
 1. Fabric: Light-blocking.
 2. Accessories:

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.

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.
- D. END OF SECTION 122413

SECTION 20 00 01

GENERAL REQUIREMENTS

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 APPLICATION

- A. The provisions of this Section applies to all heating, ventilation, air conditioning, plumbing, fire protection, and electrical work of this Contract to the extent that they do not conflict with the provisions of the General Conditions, Supplementary Conditions, Division 00, Division 01, and/or other General Contract Documents. When such conflict occurs the provisions of this Section are thereby superseded but only to the extent of the conflict.

1.3 SCOPE OF WORK

- A. The work under this Section of the Specification shall include all labor, materials, appliances, and services necessary for and incidental to the proper completion of the heating, ventilating, air conditioning, plumbing, fire protection, electrical and related work shown, implied or required by the drawings and described in these specifications.
- B. Each Contractor shall perform all necessary rigging required for completion of work under his contract.
- C. Each Contractor shall perform all necessary earthwork required for completion of work under his contract.
- D. The .1 Contractor shall perform all slab cutting and removal and site earthwork removal as to allow access to items to be demolished and installation of new items. The associated contractor shall perform the demolition and installation of new work, backfill to be by the associated contractor. Final fill and new slabs shall be by the .1 Contractor.

1.4 OWNER OCCUPANCY

- A. The Owner will not occupy the building during work under this contract.
- B. The Contractor shall be responsible for the shut-down and start-up of smoke detection systems on a daily basis, and for providing fire watches during periods when the system OFF.
- C. All hot work shall cease one (1) hour prior to the end of the work day. A fire watch inspection of all areas shall be completed at the end of each day.

1.5 QUALITY CONTROL

- A. Monitor suppliers' products and services, site conditions, and workmanship to conform to specified quality.
- B. Comply with manufacturer's instructions and with specified standards.
- C. Work shall be performed by qualified personnel.

D. References

E. Conform to current referenced standards in effect on date of contract documents.

F. Inspection and Testing Laboratory Services

1. Testing laboratory will be subject to acceptance by the Owner.
2. Submit notice in writing, 72 hours prior to testing, that Owner or his Representative can make arrangements to be on site.
3. Covered, concealed, or insulated work shall remain exposed until tested and accepted.
4. Pressure, operating and specified performance testing of components or systems shall be conducted in the presence of the Owner or his Representative.
5. Certificates of approval and/or acceptance as specified or required by regulations of agencies having jurisdiction shall be submitted prior to acceptance of work.
6. Retesting required because of non-conformance to specified requirements shall be performed by the same independent firm on instructions by the Architect/Engineer. Payment for retesting will be by the Contractor with no additional cost to the Owner.

G. Manufacturers Field Services and Reports

1. Require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, and start-up of equipment as applicable, and to initiate instructions when necessary.
2. Report observations, and decisions, and/or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.
3. Submit report in duplicate within 15 days of observation to Architect/Engineer for review.

1.6 PERMITS, LAWS, ORDINANCES AND REGULATIONS

- A. The heating, ventilation, air conditioning, plumbing, fire protection, and electrical systems shall conform to all pertinent laws, ordinances and regulations of agencies and government bodies.
- B. Contractor shall obtain all permits and inspection by each authority having jurisdiction. Contractor shall pay permit, inspection and certification fees.

1.7 DRAWINGS AND SPECIFICATIONS

- A. It is intended that these specifications and drawings shall include all materials, equipment, and labor required to correctly install and put in proper operation all systems of all work specified and/or indicated.
- B. Small items of equipment, material, apparatus or machinery not specified or indicated in detail which may be necessary to complete any part of the work as required, implied or intended shall be provided at no additional cost to the Owner.

1.8 OPERATION AND MAINTENANCE DATA

- A. Prepare two sets prior to final inspection, bound in 8 ½ x 11 inch text pages, three D side ring capacity expansion binders with durable plastic covers.
 1. Submit one copy of completed volumes in final form 15 days prior to final inspection. This copy will be returned, with Architect/Engineer comments. Revise content of documents as required prior to final submittal.

- B. Prepare binder covers with printed title, "OPERATION AND MAINTENANCE INSTRUCTIONS", title of project, and subject matter of binder when multiple binders are required.
- C. Internally subdivide the binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.
- D. Contents: Prepare a Table of Contents for each volume, with each product or system description identified type written on 24 pound white paper.
- E. Part 1: Directory listing names, addresses, and telephone numbers of Architect/Engineer, Contractor, Subcontractors, and major equipment suppliers.
- F. Part 2: Operation and maintenance instructions arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
 - 1. Significant design criteria.
 - 2. List of equipment.
 - 3. Parts list for each component.
 - 4. Operating instructions.
 - 5. Maintenance instructions for equipment and systems.
 - 6. Maintenance instructions for finishes, including recommended cleaning methods and materials and special precautions identifying detrimental agents.
- G. Part 3: Project documents and certificates, including the following:
 - 1. Shop drawings and product data.
 - 2. Air and water balance reports.
 - 3. Certificates.
 - 4. Photocopies of warranties.
- H. Submit four (4) final revised volumes within ten days after final inspection to the Architect/Engineer.

1.9 GUARANTEE

- A. All materials, equipment and workmanship shall be unconditionally guaranteed in writing for a period of one year from the date of acceptance. The Contractor shall replace or repair, at no cost to the Owner, any material, equipment or workmanship which becomes defective during the guarantee period. The Contractor shall service all equipment and systems included in this contract during guarantee period.

1.10 SITE VISIT

- A. All Bidders are required to thoroughly examine the site.
- B. Contractor shall notify the Engineer, prior to bidding, of any discrepancies between existing site conditions and requirements of contract documents. The Engineer will issue clarification prior to submission of bids. Lack of this notification to Engineer will result in binding interpretation by the Engineer.

1.11 PROJECT RECORD DOCUMENTS

- A. Maintain on site, one set of the following record documents.
 - 1. Contract Drawings.
 - 2. Specifications.
 - 3. Addenda.

4. Change Orders and other modifications to the contract.
 5. Reviewed shop drawings, product data, and samples.
- B. Store Record Documents separate from documents used for construction.
- C. Record information concurrent with construction progress.
- D. Specifications: Legibly mark and record at each product section a description of actual products installed, including the following:
1. Manufacturer's name and product model and number.
 2. Product substitutions or alternates utilized.
 3. Changes made by Addenda and Modifications.
- E. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
1. Measured horizontal and vertical locations of underground utilities and appurtenances referenced to permanent surface improvements.
 2. Measured locations of internal utilities to include pipes, valves, equipment, conduit, access doors, controls, ducts, sprinklers, fixtures, etc.
 3. Field changes of dimension and detail.
 4. Details not on original contract drawings.
- F. Delete Architect/Engineer's title block and seal from all documents.
- G. Submit documents to Architect/Engineer with claim for final Application for Payment

1.12 TEMPORARY UTILITIES, HEATING AND FACILITIES

- A. Temporary Power
1. Provide power outlets for construction operations with branch wiring and distribution boxes, as required.
- B. Temporary Lighting
1. Provide branch wiring from power source with lighting, conductors, pigtails and lamps, as required.
 2. Maintain lighting and provide routine repairs.
- C. Temporary Heat
1. Provide heat devices, as required, to permit continuity of service. Salamanders will not be permitted.
- D. Temporary Water
1. Contractor shall provide connections to existing water service.
- E. Temporary Sanitary Facilities
1. The Owner will designate facilities for use by Contractor personnel.
 2. If none are available Contractor shall provide porta-potties per regulations and have the sanitation company regularly replace the units.

F. Removal of Temporary Utilities, Heating and Facilities

1. Remove temporary above grade or buried utilities, equipment, facilities and /or materials prior to substantial completion inspection.
2. Restore existing facilities used during construction to original condition.

1.13 COORDINATION:

- A. Coordinate scheduling, submittals, and work of the various specification sections and work of other contractors, to assure efficient and orderly sequence of installation of interdependent construction elements.
- B. Verify that utility requirement characteristics of operating equipment are compatible with building utilities. Coordinate work of various specification sections having interdependent responsibilities for installing, connecting to, and placing in service such equipment.
- C. Coordinate space requirements and installation of mechanical and electrical work. Follow routing shown for pipes, ducts, and conduit as closely as practicable; place runs parallel with line of building. Utilize space efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- D. In finished areas, except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
- E. Coordinate completion and clean-up of work of separate trades in preparation for substantial completion.
- F. After Owner's occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.
- G. Prior to installing any equipment, material, device, etc. the contractors (Mechanical, Plumbing, Electrical, and Fire Protection) and all sub-contractors shall, in a coordinated effort, prepare detailed coordination drawings in AutoCAD at a minimum scale of 3/8' to 1'-0". Provide enlarged sections and plan views in congested areas to coordinate all materials and equipment. The Mechanical Contractor shall be the responsible party for preparing the base plans and coordinating with the project managers, superintendents, and foreman of the various trades.

1.14 INTERRUPTION OF UTILITIES:

- A. The Contractor shall not take any action that will interrupt any of the existing building services for this building or any other buildings without prior arrangement with the Engineer, Owner, or Owner's Representative.
- B. Contractor shall notify Engineer/Owner 7 days in advance of any interruption to building services HVAC, Plumbing, Fire Protection, Electrical, Fire Alarm, Communications, etc.
- C. The Contractor causing any unplanned utility interruption shall immediately provide all continuous labor, material and equipment necessary until such utility service is restored.

1.15 SUBSTITUTIONS

- A. Bids shall be submitted only on the basis of materials, products or equipment specified in the specifications, on the drawings, or as named by Addendum issued prior to bid date and pursuant to requests for approval.
- B. Materials, products or equipment specified in these specifications or on the drawings are specified for the purpose of establishing a standard of quality, cost, design and function. It is not the intent to limit the acceptance of materials, products or equipment specified, but rather to name or describe a material, product or piece of equipment as the absolute minimum standard that is desired and acceptable. Where proprietary names are used, whether or not followed by the words "or approved equal", they shall be subject to equals only as approved by the Engineer prior to the date for receipt of bids.
- C. No substitutions shall be considered unless written requests are submitted to the Engineer for approval ten (10) days prior to the date for receipt of bids. Such requests shall be from a Prime Contractor and shall include a complete description of the proposed substitute, documentary proof of equal or superior quality, drawings or catalog cuts clearly marking the models or lines, sample of materials, performance and test data, jobs completed locally within the past five years and any other data or information necessary for a complete evaluation.
- D. Approved substitutions will be set forth by Addenda to alert all bidders.
- E. The contract documents have been prepared to provide for the incorporation of the standard of design and construction of the specified items or assemblies of every category of materials, products or pieces of equipment. In the event that incorporation of a substituted, acceptable equivalent, or approved equal item or assembly into the work will require revisions or additions to the contractual requirements of the Prime Contractor or any Sub-contractors, the Prime Contractor or Sub-contractor electing to use such item or assembly shall bear the cost of such revisions or additions to the work of all trades without change to the Contract sum.
- F. If no prospective bidder has elected to obtain approval by the means described above, the Owner has no authority, after award of contract, to consider any brand other than those named in the Contract Documents.
- G. A substitution submitted by a Contractor or Sub-contractor after the award of contract, for reason that a product is not available, will not be permitted unless proof is submitted that a firm order was placed within 15 days after Notice of Award to the Prime Contractor. If an order was placed as stated, and the product is not available, the Contractor may submit a substitute product for review by the Owner and Architect/Engineer.

1.16 CLEANING

- A. Each Contractor and/or Sub-Contractor who is responsible for execution of individual sections of work shall be responsible for the following:
 - 1. Removal of all lumber, refuse, metal, piping and debris from site resulting from their work.
 - 2. Cleaning droppings resulting from their work, etc., from finished work of other trades.
 - 3. Cleaning, polishing, waxing of their work as required.

- B. After testing and acceptance of all work by the Architect/Engineer and the Owner, each Contractor shall thoroughly clean all equipment and material involved in his Contract to the satisfaction of the Architect/Engineer.

1.17 INSTRUCTING OWNER'S PERSONNEL

- A. After all tests and adjustments have been made, each Contractor shall fully instruct the representatives of the Owner in all details of operation of the equipment installed under his Contract.
- B. Each Contractor shall operate his equipment for sufficient length of time to satisfy the Engineer that the requirements of the Contract Documents have been fulfilled.

1.18 PIPE/DUCT TESTING

- A. All new hydronic piping and ductwork shall be tested.
 - 1. All piping shall be hydraulically tested in accordance with ASME B31.9 or as specified in individual sections.
 - a. Provide necessary components to isolate existing systems.
 - 2. All ductwork shall be leak tested in accordance with SMACNA HVAC air duct, Duct Leakage Test Manual, latest edition or as specified in individual sections.
 - a. Provide necessary components to isolate existing systems.

PART 2 - PRODUCTS

2.1 SUPPORTS AND ANCHORS

- A. Anchors of approved design shall be provided in locations shown on drawings to control movement in piping. Where types are not indicated or specified, contractor shall submit shop drawings detailing the entire anchor installation. Weld anchors to ferrous piping and braze anchors to nonferrous piping. Anchors must be made of heavy cross-sectional material and fastened securely to the building construction by anchor bolts set in the concrete or attached to the structural framing of the building as approved. Strengthen the structure at anchor points to take the additional loads.
- B. All materials, designs and types of inserts, hanger supports and clamps shall meet the requirements of the Manufacturers Standardization Society Document MSS-SP-58, latest edition and also Underwriters Laboratories, Inc., National Electrical Code and Factory Mutual Engineering Division Standards where applicable.
- C. Each Contractor shall be responsible for and provide all necessary inserts, hanger supports, fastenings, clamps and attachments necessary for support of his work. The types of all inserts, hanger supports, fastenings, clamps and attachments to be used shall be selected to suit both new and existing building construction conditions and applied specifically for the purposes intended.

2.2 ELECTROLYSIS CONTROL

- A. All copper to ferrous piping connections shall be made with the use of dielectric unions or flanges.
- B. Connection between bronze valves and ferrous piping do not require electrolysis control.

2.3 SUBMITTALS

- A. Submit shop drawings and product data for all material and equipment required under this contract. Submit the number of copies that the Contractor requires, plus three copies which will be retained by the Architect/Engineer.

- B. Present shop drawings in a clear and thorough manner. Title each drawing with Project name and number; identify each element of drawings by reference to A/E's Drawing number and detail, specification section, schedule, or room number. For product data submit only pages which are pertinent; mark each copy of standard printed data to identify pertinent products, referenced to Specification Section and Article number. Show reference standards, performance characteristics and capacities, wiring and piping diagrams and controls, component parts, finishes, dimensions, and required clearances.
- C. Allow two (2) weeks for Engineer's processing of each submittal, exclusive of Owner, Architect, or others in the processing chain. Allow a longer time period where processing must be delayed for coordination with subsequent submittals.
- D. Each Contractor shall examine all submittals before submission for review. Each Contractor shall then forward all submittals with his initialed approval stamp, and by so doing the Contractor thereby represents that he has determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers, and similar data, has notified the Architect/Engineer of site conditions varying from those indicated or specified, and that he has checked and coordinated each item with other applicable approved shop drawings and the contract requirements. Shop drawings and product data submitted without the contractor's stamp of approval will be returned to the Contractor without review.
- E. The Mechanical Contractor shall prepare 3/8" minimum scale, AutoCad Release 12 or later, sheet metal shop drawings at the earliest practicable time and coordinate these drawings with the other contractors, prior to submission for review and prior to erection of the sheet metal work, in order to effect timely resolution of all conflicts with the work of other contractors.
- F. Corrections or comments made on submittals during review by the Architect/Engineer do not relieve the contractor from compliance with requirements of the drawings and specifications. Such review shall be only for general conformance with the design concept and general compliance with the information given in the Contract Documents. It shall not include review of quantities, dimensions, weights or gauges, fabrication processes, construction methods, coordination with the work of other trades, or construction safety precautions, all of which are the sole responsibility of the Contractor. Review of a specific item shall not indicate acceptance of an assembly of which the item is a component. The Engineer shall not be responsible for any deviations from the Contract Documents not clearly noted by the Contractor, nor shall the Engineer review partial submissions or those for which submissions for correlated items have not been received. The Contractor is responsible for: confirming and correlating all quantities, clearance and dimensions, selecting fabrication processes and techniques of construction, coordinating work with that of all other trades, and performing his work in a safe and satisfactory manner.

2.4 ACCESS DOORS

- A. Each Mechanical and Electrical Contractor shall furnish and locate, for installation by the Prime Contractor, all access doors and panels for concealed portions of Mechanical and Electrical work requiring accessibility for operation and maintenance of his installed work.
- B. Steel Access Doors: Fabricate units of continuous welded steel construction with flush panel doors having concealed hinges and screwdriver operated cam locks. Provide attachment devices and fasteners of type required to secure access panels.
- C. Fabricate frame from 16 - gage steel with exposed flange nominal 1-inch wide around perimeter of frame.

1. For gypsum drywall or gypsum veneer plaster, furnish perforated frames with drywall bead.
 2. For installation in masonry construction, furnish frames with adjustable metal masonry anchors.
- D. Finish: Manufacturer's factory-applied primer coat ready for field painting.
- E. Underwriters "B" label access doors where required for access to shafts, corridors, and where located in fire walls and partitions.
- F. No access panels shall be installed without specific approval of the Architect/Engineer as to location. The proposed location of each sub-contractor panel shall be reviewed with the Architect/Engineer by the Prime Contractor's Job Superintendent before installation of equipment or panels. Controversies must be resolved at no cost to the Owner.

2.5 SLEEVES

- A. Each Contractor shall furnish all sleeves required for his work to the Prime Contractor for positioning into formwork.
- B. Sleeves shall be Schedule 40 steel pipe for piping or conduit penetrations and 18 gage galvanized steel for ductwork penetrations. Seal voids between duct/pipe and sleeve with fire retardant insulation meeting ASTM Standards.
- C. Sleeves shall extend through construction. Finish flush with wall surfaces and extend two (2) inches above floors. Each sleeve shall provide for a minimum ½" clearance around pipe or its covering in the instance of pipe covered with insulation.
- D. All sleeves in waterproof walls shall be fitted and sealed with positive hydrostatic "Link Seals" as manufactured by Thunderline Corporation. Sleeves shall be sized accordingly. Link Seals shall be placed around piping and/or conduit and inserted into void between inner wall of sleeve and piping and/or conduit. Tighten link seals as required for watertight seal. Where opening has not been cored cleanly, or in new construction, provide a properly sized sleeve set and weather proofed to prevent leakage.
- E. Voids between sleeves and piping, ductwork or conduit, where located in fire rated partitions or masonry walls shall be sealed with firestopping insulation and sealant as required to maintain the fire resistance rating of the partition.

2.6 VIBRATION CONTROL

- A. The Mechanical and Electrical Contractors shall provide vibration isolation support provisions for all moving or rotating equipment, machinery and transformers when such provisions are not furnished and/or integrally mounted by the equipment manufacturer. All vibration isolators shall be manufactured by the Mason Industries, Inc. company or approved equal and, installed in accordance with the manufacturer's recommendations.

PART 3 - EXECUTION

3.1 CONSTRUCTION

- A. The Contract Drawings cover the approximate relative positioning of the heating, ventilating, air conditioning, plumbing, fire protection, and electrical equipment. Final positioning and placement shall be determined by the contractor during coordination.
- B. The equipment shall be installed and interconnected to form complete systems in accordance with the manufacturer's instructions and current trade practices.

- C. Prior to purchasing materials or performing work, the Contractor shall confirm all dimensions and site conditions at no additional payment to the Contractor.
- 3.2 DUST CONTROL
- A. Provide temporary partitions and ceilings as required to separate work areas from Owner occupied areas to prevent penetration of dust and moisture into Owner occupied areas, and to prevent damage to existing materials and equipment.
- 3.3 LUBRICATION
- A. The Contractor providing and/or furnishing operating equipment shall be responsible for lubrication of that equipment in accordance with the equipment manufacturer's instructions.
 - 1. Complete lubrication shall be accomplished prior to start-up for any reason.
 - 2. After acceptance and prior to in-service use the Contractor shall assure that equipment is completely lubricated.
 - 3. Lubricants shall be of the type, grade and quality as specified by the equipment manufacturer.
 - B. Lubrication of operating equipment furnished by the Owner, to be installed under this contract, shall be the responsibility of the installing contractor.
 - 1. Lubrication shall be as specified above.
 - 2. The installing contractor shall obtain the equipment manufacturer's lubricating instructions.
- 3.4 MECHANICAL - ELECTRICAL COORDINATION
- A. Electrical equipment characteristics shall be as indicated.
 - 1. Mechanical contractors shall provide all motors, automatic switches, HVAC controls, automatic temperature controls, and all other controls specified, for all equipment provided under this contract except as otherwise specified or indicated.
 - a. Electrical equipment furnished shall conform to the recommendations of the mechanical equipment manufacturer, and comply with automatic temperature control requirements specified.
 - b. Mechanical contractor shall supply complete electrical wiring diagrams for use by the Electrical Contractor.
 - c. All electrical work by the mechanical contractor or his sub-contractors shall conform to the ELECTRICAL section of these specifications and all local codes and requirements.
 - d. Refer to Article 2.3 – Motors and Motor Starters.
 - 2. Starters and electrical components that are integral to any mechanical equipment shall be complete with wiring necessary for intended operation.
 - B. Piping Over Electrical Equipment
 - 1. Do not install any piping or fittings over the top of, or within a distance of six feet (6') measured horizontally from the top of all switchboards, panelboards, motor starters, metering assemblies, bus ducts and associated equipment. Where piping or fittings are installed above the required six (6') feet, provide watertight sheet metal trough around and under piping to completely contain water leakage. Provide drain provisions in troughs and pipe to nearest floor drain.
- 3.5 WELDING

- A. All welding shall be performed in accordance with the standards and recommendations of the American Welding Society by experienced welders whose qualifications are satisfactory to the Engineer.
- B. Before assigning any welder to work covered by this specification, each Contractor shall provide the Engineer with the names of pipe welders to be employed in the work, together with the certification that each of these welders has passed qualification tests as prescribed by the National Certified Pipe Welding Bureau, or other reputable testing laboratory or agency, using procedures approved by the American Society of Mechanical Engineers or the American Welding Society. If requested by the Engineer, each contractor shall submit identifying stenciled test coupons made by an operator in question. Each Contractor shall require any welder to retake a test when, in the opinion of the Engineer, the work of the welder creates a reasonable doubt as to his proficiency. Tests, when required, shall be conducted at no expense to the Owner. Re-certification of the welder shall be made to the Engineer only after the welder has taken and passed the required test.
- C. Each Contractor must adequately protect all adjacent surfaces, systems, material and building occupant during welding processes. Any damaged items must be repaired or replaced to the satisfaction of the Engineer at no additional cost to the Owner.
- D. In confined and enclosed spaces, each Contractor must provide temporary forced ventilation systems, to prevent the accumulation of smoke and odors within the building. All such temporary ventilation systems shall be discharged to building exterior.
- E. Forced ventilation and exhaust provisions shall be provided in strict accordance with the requirements of OSHA and ANSI Z49.1.

3.6 DEMOLITIONS

- A. The Contract Documents do not indicate all the existing piping and equipment that may have to be relocated or removed. Therefore, prior to submitting a bid, the Contractor shall thoroughly examine the site to familiarize himself with the existing conditions.
- B. Removals shall be performed without damage to adjacent retained work. However, where such work is damaged, the Contractor shall patch, repair or otherwise restore same to its original condition. Removals shall be as indicated or as specified herein, and shall be performed in a neat and workman like manner to the limits indicated or specified, or to the minimum extent necessary or required for the proper installation of new work. Existing surfaces remaining after removals to which new work is to be applied, shall be left in a condition suitable for application of the new work.
- C. Debris shall be placed in approved, Contractor furnished containers to prevent the spread and accumulation of dust and dirt. Debris shall be removed from the area of work as often as necessary, but not less than once at the end of each day.
- D. The Contractor shall take all necessary precautions to adequately protect personnel and public and private property in the areas of the work. Contractor will be held responsible for any damage to same.
- E. The dust resulting from removals shall be controlled so as to prevent its spread to occupied portions of the building and to avoid creation of a nuisance in the surrounding areas. On start-up, Contractor shall use temporary down stream filters over diffusers to protect the occupants from construction debris.

- F. Where new installations interfere with existing piping, equipment, etc., the Contractor shall remove the interfering material if it is not to be reused. If the interfering material is part of an existing active system, it shall be relocated to clear the obstruction using additional material if necessary, of same design and type.
- G. The Contractor shall not remove or disturb any substance which is suspected of being asbestos. He shall notify the Owner for further inspection and possible removal.
- H. The Owner has salvage right to all equipment before disposal; however, disposal of all unwanted equipment shall be the responsibility of the Contractor.

3.7 CUTTING AND PATCHING

- A. Execute cutting, fitting, and patching including excavation and fill, to complete Work, and to:
 - 1. Fit the several parts together, to integrate with other Work.
 - 2. Uncover Work to install or correct ill-timed Work.
 - 3. Remove and replace defective and non-conforming Work.
 - 4. Remove samples of installed Work for testing.
 - 5. Provide openings in elements of Work for penetrations of mechanical and electrical Work.
- B. Cut masonry and concrete materials using masonry saw or core drill. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.
- C. Employ skilled installer to perform patching work. Refinish surfaces to match adjacent finishes in texture and color. For continuous surfaces, refinish to nearest intersection; for an assembly, refinish entire unit.

3.8 CLOSEOUT

- A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents, revised shop drawings, approved change orders and punch list items have been resolved to Architect/Engineer/Owner's satisfaction.
- B. Provide submittals to Architect/Engineer/Owner that are required by governing or other authorities.

END OF SECTION 200001

SECTION 20 00 02

DEFINITIONS

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 DEFINITIONS

General: Except as specifically defined otherwise, the following definitions, compiled in random order, supplement definitions of the Contract, General Conditions, Supplementary Conditions Division 00, and Division 01 and other general contract documents, and apply to the work. Definitions of the General Conditions, Supplementary Conditions, Division 00, Division 01, and other general contract conditions supersede those in this Section when in conflict and only to the extent of such conflict.

- A. The Contract Documents: The Contract Documents consist of the Agreement, the Waiver of Liens, and Exhibits thereto, the Conditions of the Contract (General, Supplementary and other Conditions), Contract Bond (Performance and payment), the Drawings, the Specifications, all Addenda issued prior to execution of the Contract, and all Modifications thereto. A Modification is (1) a written amendment to the Contract signed by both parties, (2) a Change Order, (3) a written interpretation issued by the Architect/Engineer, (4) a written order for a minor change in the Work issued by the Architect/Engineer. A Modification may be made only after execution of the Contract.
- B. The Contract: The Contract Documents form the Contract. The Contract represents the entire and integrated agreement between the parties hereto and supersedes all prior negotiations, representations, or agreements, either written or oral, including the bidding documents. The Contract may be amended or modified only by a Modification as defined above.
- C. The Work: The term "Work" includes all labor necessary to produce the construction required by the Contract Documents, and all materials and equipment incorporated or to be incorporated in such construction.
- D. The Project: The "Project" is the total construction designed by the Architect/Engineer of which the Work performed under the Contract Documents may be the whole or a part.
- E. The Prime Contractor: The Prime Contractor is the person or entity with whom the Owner executes the Contract for the Project and is referred to throughout the Contract Documents as if singular in number and masculine in gender. The term "Contractor" means the Prime Contractor or his authorized representative.
- F. Contractor: A person or entity who has a direct contract with the Prime Contractor to perform any of the work at the site. The term "Contractor" is referred to throughout the Contract Documents as if singular in number and masculine in gender and means a

Contractor, his authorized representative, or any of his Subcontractors or Sub-subcontractors.

- G. Subcontractor: A person or entity who has a direct contract with the Contractor to perform any of the work at the site. The term "Subcontractor" is referred to throughout the Contract Documents as if singular in number and masculine in gender and means a Subcontractor, his authorized representative, or any of his Sub-subcontractor.
- H. Sub-subcontractor: A person or entity who has a direct or indirect contract with a Contractor to perform a portion of the Work at the site. The term "Sub-subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Sub-subcontractor or an authorized representative of the Sub-subcontractor.
- I. Shop Drawings: Drawings, diagrams, submittals, schedules and other data specially prepared for the Work by the Contractor or a Subcontractor, Sub-subcontractor, manufacturer, supplier or distributor to illustrate some portion of the Work.
 - 1. Product Data: Illustrations, standard schedules, performance charts, instructions, brochures, diagrams and other information furnished by the Contractor to illustrate materials or equipment for some portion of the Work.
 - 2. Samples: Physical examples which illustrate materials, equipment or workmanship and establish standards by which the Work will be judged.
 - 3. Shop Drawings, Product Data, Samples and similar submittals are not Contract Documents. The purpose of their submittal is to demonstrate for those portions of the Work for which submittals are required the way the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents.
- J. Substantial Completion: The stage in the progress of the Work when the Work or designated portion thereof is sufficiently complete in accordance with the Contract Documents so the Owner can occupy or utilize the Work for its intended use.
- K. "Specified": Described, noted or scheduled in the project documents.
- L. Indicated: Shown on drawings by notes, graphics or scales. Terms such as "shown" or "scheduled" have same meaning as "indicated".
- M. Directed, requested, approved, accepted, etc.: These terms imply "by the Architect's/Engineer", unless otherwise indicated. No implied meaning shall be interpreted to extend the Architect's/Engineer's responsibility into the Contractor's supervision of construction.
- N. Reviewed by Architect/Engineer: In no case releases Contractor from responsibility to fulfill requirements of contract documents.
- O. Project Site: Space available to Contractor at location of project, either exclusively or to be shared with separate contractors for performance of the work.
- P. Furnish: Supply and deliver to project site, for installation by other than entity furnishing.
- Q. Install: Operations at project site, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning of items furnished to Contractor

- R. Provide: Furnish and install, complete and ready for intended use.
- S. Installer: Entity (firm or person) engaged to install work, by Contractor, sub-contractor or sub-subcontractor. Installers are required to be skilled in work they are engaged to install.
- T. Specification Text Format: Underscoring facilitates scan reading, it has no other meaning. Imperative language is directed at Contractor, unless otherwise noted.
- U. Overlapping/Conflicting Requirements: Most stringent (generally) language written directly into contract documents applies, unless document clearly indicates that a less stringent requirement is acceptable. Refer uncertainties to Architect/Engineer for decision before proceeding. Where optional requirements are specified in a parallel manner, option is intended to be Contractor's unless otherwise indicated.
- V. Minimum Requirements: Indicated requirements are for a specific minimum acceptable level of quality/quantity, as recognized in the industry. Refer uncertainties to Architect/Engineer before proceeding.
- W. Contract Time: Unless otherwise provided, Contract Time is the period of time, including authorized adjustments, allotted in the Contract Documents for Substantial Completion of the Work.
1. The date of commencement of the Work is the date established in the Agreement. The date shall not be postponed by the failure to act of the Contractor or of persons or entities for which the Contractor is responsible.
 2. The term "day" as used in the Contract Documents shall mean calendar day unless otherwise specifically defined.
- X. Abbreviations, Plural Words: Abbreviations, where not defined in contract documents, will be interpreted to mean the normal construction industry terminology, determined by recognized grammatical rules, by the Architect/ Engineer. Plural words will be interpreted as plural where applicable in the context of contract documents.
- Y. Testing Laboratory: An independent entity engaged for the project to provide inspections, tests interpretations, reports and similar services.
- Z. Industry Standards: Applicable standards of construction industry have same force and effect on performance of the work as if copied directly into contract documents or bound and published therewith. Standards references in contract documents or in governing regulations have precedence over non-referenced standard, insofar as different standards may contain overlapping or conflicting requirements. Comply with standards in effect as of date of contract documents, unless otherwise indicated.

PART 2 - PRODUCT DEFINITIONS

REFER TO PRODUCT SPECIFICATION SECTIONS THROUGHOUT

PART 3 - NOT APPLICABLE

END OF SECTION 200002

SECTION 20 05 13

MOTOR REQUIREMENTS

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 SECTION INCLUDES

- A. Single phase electric motors.
- B. Three phase electric motors.

1.3 RELATED SECTIONS

- A. General Conditions of the Construction Services Agreement.
- B. Division 1 - All Sections

1.4 REFERENCES

- A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- C. IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.
- D. NEMA MG 1 - Motors and Generators.
- E. NFPA 70 - National Electrical Code.

1.5 SUBMITTALS

- A. Submit under provisions of Section 01 33 00.
- B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 01 70 00.
- B. Operation Data: Include instructions for safe operating procedures.

- C. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in the manufacture of electric motors for Mechanical and Industrial use, and their accessories, with minimum three years documented product development, testing, and manufacturing experience.

1.8 REGULATORY REQUIREMENTS

- A. Conform to NFPA 70 and NEMA MG1.
- B. Provide certificate of compliance from authority having jurisdiction indicating approval of high efficiency motors.
- C. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc., as suitable for the purpose specified and indicated.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Section 01 60 00.
- B. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.10 WARRANTY

- A. Provide five (5) year warranty under provisions of Section 01 70 00.
- B. Warranty: Include coverage entire motor.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Baldor Electric Company (Basis of Design)
 - 2. Marathon
 - 3. U.S. Motors
 - 4. Or equal as approved by the Professional

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Electrical Service:
 - 1. Motors ½ HP and Smaller: 115 volts, single phase, 60 Hz, unless otherwise specified.
 - 2. Motors Larger than ¾ Horsepower: 208 volts, three phase, 60 Hz.
 - 3. Valve Actuators: 208 volts, three phase, 60 Hz, unless otherwise specified.

- B. Type:
1. Totally enclosed fan cooled except where specifically noted otherwise.
 2. Motors: Design for continuous and/or intermittent, and variable frequency drive operation in 40 degrees C environment. Drive speed range shall meet equipment manufacturers requirements for specific application.
 3. Design for temperature rise in accordance with NEMA MG 1 limits for minimum Class F insulation or better as required to meet Article 2.2.B.5 below and be one level greater than motor temperature rise, 1.15, service factor, and motor enclosure type.
 4. Motors shall be premium energy efficient type, where available.
 5. Motors for variable speed applicators shall be designed and manufactured in accordance with NEMA MG1, Section IV, Part 31 – Definite-Purpose-Inverter-Fed Polyphase Motors.
- C. Visible Metal Stamped Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, and efficiency.
- D. Wiring Terminations:
1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
 2. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

2.3 SINGLE PHASE POWER - CAPACITOR START MOTORS

- A. Starting Torque: Three times full load torque.
- B. Starting Current: Less than five times full load current.
- C. Pull-up Torque: Up to 350 percent of full load torque.
- D. Breakdown Torque: Approximately 250 percent of full load torque.
- E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, pre-lubricated sleeve bearings.

2.4 THREE PHASE POWER - MOTORS

- A. Starting Torque: Between one and one and one-half times full load torque.
- B. Starting Current: Six times full load current.
- C. Power Output, Locked Rotor Torque, Breakdown or Pullout Torque: NEMA Design B characteristics.
- D. Design, Construction, Testing, and Performance: Conform to ANSI/NEMA MG 1 Part 31.

- E. Insulation System: NEMA Class F or better, variable speed applications, as required to meet Article 2.2.B.5 above.
- F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine freedom from electrical or mechanical defects and compliance with performance data.
- G. Motor Frames: NEMA standard T-frames of steel, or cast iron with end brackets of cast iron with steel inserts.
- H. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provisions for re-lubrication, rated for minimum AFBMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V- belt pulley with belt centerline at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- I. Sound Power Levels: To NEMA MG 1.
- J. Nominal Efficiency: As scheduled.
- K. Nominal Power Factor: As scheduled at full load and rated voltage when tested in accordance with IEEE 112. Furnish motors with power factor correction capacitors to correct nominal power factor to a minimum of 0.95.
- L. Shaft Grounding Rings:
 - 1. All VFD controlled or operated motors shall be provided with shaft-grounding rings. These devices will provide an electrical current path from the shaft to the motor housing to avoid bearing damage.
 - 2. Grounding rings shall be maintenance free, circumferential, conductive type - micro fiber shaft grounding rin to discharge shaft currents to ground.
 - 3. Manufacturer:
 - a. Electro Static Technology – AEGIS Bearing Protection Ring
 - 4. Select correct ring by cross referencing motor NEMA frame with manufacturers recommended kit and as needed to fit shaft diameter.
 - 5. Provide SGE Split Ring type rings with minimum 200,000 hour life. Maximum wear shall be less than 0.001 inches in 10,000 hours of operation.
 - 6. Maximum Temperature Rating – 410°F.
 - 7. Minimum Temperature Rating – minus 112°F.
 - 8. Designed for bi-directional rotation.
 - 9. Current Rating – 10.0 Amps high frequency up to 100 Mhz.
 - 10. Installation:
 - a. Up to 100 HP – install rings on either end of the shaft (drive end or non-drive end) to protect all motor bearings.
 - b. Above 100 HP – Insulate the non-drive bearing and install grounding ring on the drive end of the motor.
 - 11. Apply silver flake (less than 1 um) conductive shaft surface coating 360 degrees around the motor shaft where the grounding ring fibers contact the shaft.

2.5 EC MOTORS (ECM)

- A. Motor shall be an electronic commutation (EC) motor specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors. Motors shall be permanently lubricated with heavy-duty ball bearings to match the fan load and prewired to the specific voltage and phase. Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by a 0-10 VDC signal. Motor shall be a minimum of 85% efficient at all speeds.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
C. Check line voltage and phase and ensure agreement with nameplate.

3.2 GROUNDING SHAFT INSTALLATION

- A. Factory install shaft grounding rings per manufacturers recommendations.
B. Verify shaft surface is free of all coatings or finishes that reduce conductivity.
C. Apply a conductive shaft surface coating per manufacturer's recommendations.
D. Do not install rings over shaft keyways.

3.3 NEMA MOTOR RATINGS

Service Factors:

HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6-1/3	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15
1	1.25	1.15	1.15	1.15
1.5-150	1.15	1.15	1.15	1.15
200 & Above	1.15	1.15	1.15	1.15

Efficiency and Power Factors:

HP	Minimum % Efficiency	Nominal Power Factor*
1/12 - 1/3	81	72
1/3 - 1/2	81	84
1/2 - 1.5	84	85
1.5 - 75	90	86
100 - 200	95	87
Above 200	95.4	89.5

*Correct non-VFD operated motors to minimum 0.95 with correction capacitors.

3.4 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
B. Perform inspections and tests listed in NETA ATS, Section 7.15.

END OF SECTION 200513

SECTION 20 05 29

HANGERS AND SUPPORTS FOR HVAC AND PLUMBING PIPING AND 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. Pipe hangers and supports.
2. Accessories
3. Formed Steel Channel
4. Firestopping.
5. Firestopping accessories.

B. Related Sections:

1. Section 03 10 00 - Concrete Forming and Accessories: Execution requirements for placement of inserts sleeves in concrete forms specified by this section.
2. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for placement of concrete housekeeping pads specified by this section.
3. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
4. Section 07 90 00 - Joint Protection: Product requirements for sealant materials for placement by this section.
5. Section 09 90 00 - Painting and Coating: Product and execution requirements for painting specified by this section.
6. Section 23 07 00 - HVAC Insulation: Product and execution requirements for piping insulation.
7. Section 23 21 13 - Hydronic Piping: Execution requirements for placement of hangers and supports specified by this section.
8. Section 23 22 13 - Steam and Condensate Heating Piping: Execution requirements for placement of hangers and supports specified by this section.
9. Section: Installation requirements for roof flashing installation.

1.3 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B31.1 - Power Piping.
2. ASME B31.5 - Refrigeration Piping.
3. ASME B31.9 - Building Services Piping.

B. ASTM International:

1. ASTM C209 – Standard Test Methods for Cellulosic Fiber Insulating Board.
 2. ASTM C518 – Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 3. ASTM C1136 – Standard Specifications for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
 4. ASTM D 1621 – Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
 5. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
 6. ASTM E96 – Standard Test Methods for Water Vapor Transmission of Materials.
 7. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 8. ASTM E814 - Standard Test Method for Fire Tests of Through Penetration Fire Stops.
 9. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
 10. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
- C. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.
- D. FM Global:
1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.
- E. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
 2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
 3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- F. Underwriters Laboratories Inc.:
1. UL 263 - Fire Tests of Building Construction and Materials.
 2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
 3. UL 1479 - Fire Tests of Through-Penetration Firestops.
 4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
 5. UL - Fire Resistance Directory.

1.4 DEFINITIONS

- A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.5 SYSTEM DESCRIPTION

- A. Firestopping Materials: ASTM E119 ASTM E814 UL 263 UL 1479 to achieve fire ratings for adjacent construction, but not less than 1 hour fire rating.
1. Ratings may be 3-hours for firestopping in through-penetrations of 4-hour fire rated assemblies unless otherwise required by applicable codes.

1.6 PERFORMANCE REQUIREMENTS

- A. Firestopping: Conform to applicable code FM and UL WH for fire resistance ratings and surface burning characteristics.
- B. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.7 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.
- C. Product Data:
 - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
 - 2. Firestopping: Submit data on product characteristics, performance and limitation criteria.
- D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.
- E. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- F. Manufacturer's Installation Instructions:
 - 1. Firestopping: Submit preparation and installation instructions.
- G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- H. Engineering Judgments: For conditions not covered by UL listed designs, submit judgments by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

1.8 QUALITY ASSURANCE

- A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 or ASTM E814 with 0.10 inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings of adjacent construction, but not less than 1-hour.
 - 1. Wall Penetrations: Fire F-Ratings equal to adjacent construction, but not less than 1-hour.
 - 2. Floor and Roof Penetrations: Fire F-Ratings and temperature T-Ratings equal to adjacent construction, but not less than 1-hour.
 - a. Floor Penetrations Within Wall Cavities: T-Rating is not required.

- B. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.
 - 1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
 - 2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.
- C. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating for assembly in which joint is installed.
- D. Fire Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.
- E. Surface Burning Characteristics: Maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
- F. Perform Work in accordance with applicable authority AWS D1.1 for welding hanger and support attachments to building structure.
- G. Perform Work in accordance with State Municipality of Highways Public Work's standard.
- H. Maintain one copy of each document on site.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum years documented experience approved by manufacturer.

1.10 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

- C. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.12 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60°F.
- C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.
- D. Provide ventilation in areas to receive solvent cured materials.

1.13 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.14 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for pipe hangers and supports.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Cooper B-Line (Basis of Design)
 - 2. National Pipe Hanger.
 - 3. Anvil international.
 - 4. Or equal as approved by the Professional.
- B. Hydronic and Domestic Water Piping:
 - 1. Conform to ASME B31.9 ASTM F708 MSS SP58 MSS SP69 MSS SP89.
 - 2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron Carbon steel, adjustable swivel, split ring.
 - 3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
 - 4. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
 - 5. Hangers for Hot Pipe Sizes 6 inches and Larger: Adjustable steel yoke, cast iron roll, double hanger.
 - 6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.
 8. Vertical Support: Steel riser clamp.
 9. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 10. Floor Support for Hot Pipe Sizes 4 Inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 11. Floor Support for Hot Pipe Sizes 6 inches and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
 12. Copper Pipe Support: Copper Guard Split Ring.
- C. Plumbing Piping – Sanitary, Storm, and Vent:
1. Conform to ASME B31.9, ASTM F708, MSS SP58, MSS SP69, and MSS SP89.
 2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: carbon steel, clevis, adjustable swivel, split ring.
 3. Hangers for Pipe Sizes 2 inches and Larger, carbon-steel, clevis, adjustable ring.
 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 5. Vertical Support: Steel riser clamp.
 6. Copper piping: Copper Guard Split Ring.

2.2 ACCESSORIES

- A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

2.3 FORMED STEEL CHANNEL

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
1. Allied Tube & Conduit Corp. (Basis of Design)
 2. B-Line Systems
 3. Midland Ross Corporation, Electrical Products Division
 4. Unistrut Corp.
 5. Or equal as approved by the Professional.
- B. Product Description: Galvanized steel.
- C. Sizing Criteria: Sized to provide a Load Safety Factor of 5.0 above maximum static and dynamic loads. Equipment that is to be hung shall have supports and rods sized for 1.5x the equipment weight and safety factor listed above.
- D. Submit calculations prepared by a Licensed Professional Engineer in the State of New Jersey.

2.4 FIRESTOPPING

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
1. Dow Corning Corp. (Basis of Design)
 2. Fire Trak Corp.
 3. Hilti Corp.
 4. International Protective Coating Corp.

5. 3M fire Protection Products
 6. Specified Technology, Inc.
 7. Or equal as approved by the Professional.
- B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
1. Silicone Firestopping Elastomeric Firestopping: Single multiple component silicone elastomeric compound and compatible silicone sealant.
 2. Foam Firestopping Compounds: Single multiple component foam compound.
 3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
 4. Fiber Stuffing and Sealant Firestopping: Composite of mineral ceramic fiber stuffing insulation with silicone elastomer for smoke stopping.
 5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
- C. Color: As selected from manufacturer's full range of colors.

2.5 FIRESTOPPING ACCESSORIES

- A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.
- B. Dam Material: Permanent:
1. Mineral fiberboard.
 2. Mineral fiber matting.
 3. Sheet metal.
 4. Alumina silicate fire board.
- C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.
- D. General:
1. Furnish UL listed products or products tested by independent testing laboratory.
 2. Select products with rating not less than rating of wall or floor being penetrated.
- E. Non-Rated Surfaces:
1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
 2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify openings are ready to receive sleeves.
- C. Verify openings are ready to receive firestopping.
- D. Examine piping to receive insulated piping saddles
- E. Notify Engineer of conditions that would adversely affect installation.
- F. Do not begin installation until all unacceptable conditions are corrected.

3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
- B. Remove incompatible materials affecting bond.
- C. Install backing damming materials to arrest liquid material leakage.
- D. Obtain permission from Architect/Engineer before using powder-actuated anchors.
- E. Do not drill or cut structural members.

3.3 INSTALLATION - INSERTS

- A. Install inserts for placement in concrete forms.
- B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above flush with top of recessed into and grouted flush with slab.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.1 ASME B31.5 ASME 31.9 ASTM F708 MSS SP 58 MSS SP 69 MSS SP 89.
- B. Support horizontal piping as scheduled.
- C. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow, flange, valve, or fittings.
- E. Use hangers with 1-1/2 inch minimum vertical adjustment.
- F. Support vertical piping at every floor.
- G. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.
- I. Provide copper plated hangers and supports for copper piping sheet lead packing between hanger or support and piping.
- J. Design hangers for pipe movement without disengagement of supported pipe.
- K. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- L. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 22 07 00.
- M. Install insulated piping saddles at all hanger locations serving insulated piping in accordance with manufacturer's instructions.
- N. Secure and seal vapor retarder jacket in place and to adjoining insulation with self-seal adhesive tape.
- O. Center insulated piping saddle inside clevis or strut hanger.

3.5 INSTALLATION - EQUIPMENT SUPPORTS

- A. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

- B. Construct supports of steel members formed steel channel steel pipe and fittings. Brace and fasten with flanges bolted to structure.
- C. Provide rigid anchors for pipes after vibration isolation components are installed. Refer to Section 21 05 48.

3.6 INSTALLATION - FIRESTOPPING

- A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, and other items, requiring firestopping.
- B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.
- C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating, to uniform density and texture.
- D. Place foamed material in layers to ensure homogenous density, filling cavities and spaces. Place sealant to completely seal junctions with adjacent dissimilar materials.
- E. Remove dam material after firestopping material has cured. Dam material to remain.
- F. Fire Rated Surface:
 - 1. Seal opening at floor, wall, partition, ceiling, and roof as follows:
 - a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
 - b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
 - c. Pack void with backing material.
 - d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
 - 2. Where cable tray, bus, cable bus, conduit, wireway, trough, and penetrates fire rated surface, install firestopping product in accordance with manufacturer's instructions.
- G. Non-Rated Surfaces:
 - 1. Seal opening through non-fire rated wall, partition floor, ceiling, and roof opening as follows:
 - a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
 - b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
 - c. Install type of firestopping material recommended by manufacturer.
 - 2. Install escutcheons floor plates or ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
 - 3. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, in accordance with manufacturer's instructions.

4. Interior partitions: Seal pipe penetrations at clean rooms, laboratories, hospital spaces, computer rooms, telecommunication rooms, data rooms and apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

3.7 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.8 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Clean adjacent surfaces of firestopping materials.

3.9 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Protect adjacent surfaces from damage by material installation.

3.10 SCHEDULES

- A. Heating and Cooling Hanger Spacing:

PIPE SIZE Inches	COPPER TUBING MAX. HANGER SPACING Feet	STEEL PIPE MAX. HANGER SPACING Feet	COPPER TUBING HANGER ROD DIAMETER Inches	STEEL PIPE HANGER ROD DIAMETER Inches
1/2	5	7	3/8	3/8
3/4	5	7	3/8	3/8
1	6	7	3/8	3/8
1-1/4	7	7	3/8	3/8
1-1/2	8	9	3/8	3/8
2	8	10	3/8	3/8
2-1/2 (Note 2)	9	11	1/2	1/2
3	10	12	1/2	1/2
4	12	14	1/2	5/8
5	13	16	1/2	5/8
6	14	17	5/8	3/4
8	16	19	3/4	3/4

B. Plumbing Piping Hanger Spacing:

PIPE MATERIAL	MAXIMUM HANGER SPACING Feet	HANGER ROD DIAMETER Inches
Cast Iron (All Sizes)	5	5/8
Cast Iron (All Sizes) with 10 foot length of pipe	10	5/8
CPVC, 1 inch and smaller	3	1/2
CPVC, 1-1/4 inches and larger	4	1/2
Copper Tube, 1-1/4 inches and smaller	6	1/2
Copper Tube, 1-1/2 inches and larger	10	1/2

END OF SECTION 200529

SECTION 20 05 30

VIBRATION ISOLATION

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 SECTION INCLUDES

- A. Vibration isolation.

1.3 RELATED SECTIONS

- A. General Conditions of the Construction Services Agreement.
- B. Division 01 - All Sections.
- C. Section 20 00 01 - General Requirements.
- D. Section 20 00 02 - Definitions.
- E. Section 20 05 29 - Hangers and Supports.
- F. Section 23 21 13 - Hydronic Piping

1.4 REFERENCES

- A. Air Conditioning and Refrigeration Institute.
 - 1. ARI 575 – Method of measuring machinery sound within equipment space.
- B. Sheet metal and air conditioning contractors: SMACNA – HVAC Duct Construction Standard – Metal and flexible.

1.5 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Shop Drawings: Indicate and locate vibration isolators, with static and dynamic load on each.
- C. Product Data: Provide schedule of vibration isolator type with location and load on each.
- D. Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.
- E. Manufacturer's Certificate: Certify that isolators are properly installed and adjusted to meet or exceed specified requirements.

1.6 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01.
- B. Record actual locations of hangers including attachment points.

PART 2 PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Spring Hangers:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. The VMC Group, Model HRSPA (Basis of Design)
 - b. Mason
 - c. Kinetics Noise Control
 - d. Or equal as approved by the Professional
 - 2. Spring Isolators: Piping systems:
 - a. For Exterior, Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 - 3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection with retainers.
 - 4. Housings: Rectangular steel box capable of 200% minimum overload without visible deformation. Incorporate elastomer hanger with threaded insert.
 - 5. Misalignment: Capable of 20-degree hanger rod misalignment.
 - 6. Load transfer plate to hold piping at fixed elevation during installation and permit transferring load to spring after installation.

PART 3 EXECUTIONS

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install spring hangers without binding.
- C. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
- D. Install spring type hangers on all piping systems at connections to rotating equipment. Continue spring type hanger supports for a minimum of 5 supports upstream and downstream of the equipment or 40 pipe diameters of run, whichever is greater.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Examine systems under provisions of Division 00 and 01.

- B. Provide field supervision to assure correct installation and alignment.
- C. Inspect isolated equipment after installation and submit report. Include static deflections.

END OF SECTION 200530

SECTION 20 05 53

IDENTIFICATION FOR PIPING AND 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. Nameplates.
 - 2. Tags.
 - 3. Stencils.
 - 4. Pipe markers.
 - 5. Ceiling tacks.
 - 6. Labels.
 - 7. Lockout devices.

1.3 REFERENCES

- A. American Society of Mechanical Engineers:
 - 1. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit manufacturers catalog literature for each product required.
- C. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Samples: None required.
- E. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.
- F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.6 QUALITY ASSURANCE

- A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.
- B. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.8 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 NAMEPLATES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Craftmark Identification Systems (Basis of Design)
 - 2. Safety Sign Co.
 - 3. Seton Identification Products.
 - 4. Or equal as approved by the Professional
- B. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.2 TAGS

- A. Plastic Tags:
 - 1. Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inches diameter square.
- B. Metal Tags:
 - 1. Brass Aluminum Stainless Steel with stamped letters; tag size minimum 1-1/2 inches diameter square with finished edges.
- C. Information Tags:
 - 1. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.

- D. Tag Chart: Typewritten letter size list of applied tags and location in anodized aluminum frame plastic laminated.

2.3 STENCILS

- A. Stencils: With clean cut symbols and letters of following size:
 - 1. Up to 2 inches Outside Diameter of Insulation or Pipe: 1/2 inch high letters.
 - 2. 2-1/2 to 6 inches Outside Diameter of Insulation or Pipe: 1-inch high letters.
 - 3. Over 6 inches Outside Diameter of Insulation or Pipe: 1-3/4 inches high letters.
 - 4. Ductwork and Equipment: 1-3/4 inches high letters.
- B. Stencil Paint: As specified in Section 09 90 00, semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

2.4 PIPE MARKERS

- A. Color and Lettering: Conform to ASME A13.1.
 - 1. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.
- B. Plastic Tape Pipe Markers:
 - 1. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

2.5 CEILING TACKS

- A. Description: Steel with 3/4 inch diameter color-coded head.
- B. Color code as follows:
 - 1. HVAC equipment: Yellow.
 - 2. Fire dampers/smoke dampers: Red.
 - 3. Plumbing valves: Green.
 - 4. Heating/cooling valves: Blue.

2.6 LABELS

- A. Description: Aluminum Polyester Laminated Mylar, size 1.9 x 0.75 inches, adhesive backed with printed identification and bar code.

2.7 LOCKOUT DEVICES

- 1. Anodized aluminum Reinforced nylon hasp with erasable label surface; size minimum 7-1/4 x 3 inches.
- B. Valve Lockout Devices:
 - 1. Nylon Steel Plastic device preventing access to valve operator, accepting lock shackle.

PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

- A. Install identifying devices after completion of coverings and painting.
- B. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.
- C. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.
- D. Install tags using corrosion resistant chain. Number tags consecutively by location.
- E. Identify air handling units, air terminal units, exhaust fans, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Identify in-line pumps and other small devices with tags.
- F. Identify control panels and major control components outside panels with plastic nameplates.
- G. Identify valves in main and branch piping with tags.
- H. Identify air terminal units and radiator valves with numbered tags.
- I. Tag automatic controls, instruments, and relays. Key to control schematic.
- J. Identify piping, concealed or exposed, with plastic pipe markers plastic tape pipe markers. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.
- K. Identify ductwork with plastic nameplates. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
- L. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment. Coordinate with Architect **PRIOR** to installing tacks.

END OF SECTION 200553

SECTION 20 05 90

MECHANICAL PAINTS AND COATINGS

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 field application of paints and other coatings.

- B. Related Sections:

Section 20 05 31	-	Supports and Anchors
Section 20 05 53	-	Identification
Section 21 05 00	-	Common Work Results For Fire Suppression
Section 21 13 13	-	Wet-Pipe Sprinkler Systems
Section 22 11 00	-	Plumbing Piping
Section 23 07 03	-	Piping Insulation
Section 23 07 09	-	Equipment Insulation
Section 23 21 13	-	Hydronic Piping
Section 23 21 16	-	Hydronic Specialties
Section 26 05 33	-	Conduit
Section 26 05 32	-	Boxes
Section 26 05 29	-	Supporting Devices
Section 26 05 53	-	Electrical Identification

1.3 REFERENCES

- A. American Society for Testing and Materials:
1. ASTM D16 – Terminology relating to Paint, Varnish, Lacquer, and Related Products.
- B. National Association of Corrosion Engineers: NACE – Industrial Maintenance Painting.
- C. National Paint and Coatings Association: NPCA – Guide to U.S. Government Paint Specifications.
- D. Painting and Decorating Contractors of America: PDCA – Architectural Specifications Manual.
- E. Steel Structures Painting Council: SSPC – Steel Structures Painting Manual.

1.4 DEFINITIONS

- A. Conform to ASTM D16 for interpretation of terms used in this section.

1.5 SYSTEM DESCRIPTION

- A. Surface Burning Characteristics: Maximum 25/450 flame spread/smoke developed rating when tested in accordance with ASTM E84.

1.6 SUBMITTALS

- A. Section 01 33 00 – Submittal Procedures: Submittal procedures.
- B. Product Data: Submit data on all finishing products and coatings.
- C. Samples:
 - 1. Submit two paper chip samples, 3x3 inch in size illustrating range of colors and textures available for each surface finishing product scheduled.
 - 2. Submit two painted samples, illustrating selected colors and textures for each color and system selected with specified coats cascaded. Submit on tempered hardboard, 6x6 inch in size.
- D. Manufacturer's Installation Instructions: Submit special surface preparation procedures, and substrate conditions requiring special attention.

1.7 OPERATION AND MAINTENANCE DATA

- A. Section 01 70 00 – Execution and Closeout Requirements.
- B. Operation and Maintenance Data: Submit data on cleaning, touch-up, and repair of painted and coated surfaces.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience.
- B. Applicators: Company specializing in performing the work of this section with minimum three years documented experience.

1.9 PRE-INSTALLATION MEETING

- A. Section 01 30 00 – Administration Requirements: Preinstallation meeting.
- B. Convene minimum one week prior to commencing Work of this section.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 – Product Requirements: Product storage and handling requirements.
- B. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

- C. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- D. Paint Materials: Store at minimum ambient temperature of 45°F and a maximum of 90°F, in ventilated area, and as required by manufacturer's instructions.

1.11 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 – Product Requirements.
- B. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- C. Do not apply exterior coatings during rain or snow when relative humidity is outside the humidity ranges, or moisture content of surfaces exceed those required by the paint product manufacturer.
- D. Minimum Application Temperatures for Latex Paints: 45°F for interiors; 50°F for exterior; unless required otherwise by manufacturer's instructions.
- E. Minimum Application Temperature for Varnish and Stain Finishes: 65°F for interior or exterior, unless required otherwise by manufacturer's instructions.
- F. Provide lighting level of 80 ft candle measured mid-height at substrate surface.

1.12 SEQUENCING

- A. Section 01 10 00 – Summary of Work.
- B. Sequence application to the following:
 - 1. Do not apply finish coats until paintable sealant is applied.

1.13 WARRANTY

- A. Section 01 70 00 – Execution and Closeout Requirements: Product warranties and product bonds.
- B. Provide five year manufacturer warranty for paints and coatings.

1.14 EXTRA MATERIALS

- A. Section 01 70 00 – Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Supply 1 gallon of each color, type, and surface texture; store where directed.
- C. Label each container with color, type, texture, room location, in addition to the manufacturer's label.

PART 2 - PRODUCTS

2.1 PAINTS AND COATINGS

A. Standard of Design and Construction:

1. M.A. Bruder & Sons

B. Acceptable Manufacturers:

1. Sherwin-Williams.
2. Benjamin Moore.

2.2 COMPONENTS

A. Coatings: Ready mixed, except field catalyzed coatings. Prepare coatings:

1. To a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating.
2. For good flow and brushing properties.
3. Capable of drying or curing free of streaks or sags.

B. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve the finishes specified; commercial quality.

C. Patching Materials: Latex filler.

D. Fastener Head Cover Materials: Latex filler.

2.3 FINISHES

A. Refer to schedule at end of section for surface finish schedule.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 – Administration Requirements: Coordination and project conditions.

B. Verify that surfaces and substrate conditions are ready to receive Work as instructed by the product manufacturer.

C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.

D. Test shop applied primer for compatibility with subsequent cover materials.

E. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:

1. Plaster and Gypsum Wallboard: 12 percent.
2. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.

3. Concrete Floors: 8 percent.

3.2 PREPARATION

- A. Surface Appurtenances: Remove electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.
- B. Surfaces: Correct defects and clean surfaces which affect work of this section. Remove or repair existing coatings that exhibit surface defects.
- C. Marks: Seal with shellac those which may bleed through surface finishes.
- D. Impervious Surfaces: Remove mildew by scrubbing with solution of tetra-sodium or tri-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- E. Aluminum Surfaces Scheduled for Paint Finish: Remove surface contamination by steam or high-pressure water. Remove oxidation with acid etch and solvent washing. Apply etching primer immediately following cleaning.
- F. Insulated Coverings: Remove dirt, grease, and oil from canvas and cotton.
- G. Galvanized Surfaces: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer.
- H. Gypsum Board Surfaces: Fill minor defects with filler compound. Spot prime defects after repair.
- I. Uncoated Steel and Iron Surfaces: Remove grease, mill scale, weld splatter, dirt, and rust. Where heavy coatings of scale are evident, remove by hand, power tool, wire brushing or sandblasting; clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Spot prime paint after repairs.
- J. Concrete and Unit Masonry Surfaces Scheduled to Receive Paint Finish: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.
- K. Shop Primed Steel Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces.
- L. Metal Doors Scheduled for Painting: Prime metal door top and bottom edge surfaces.

3.3 APPLICATION

- A. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- B. Apply each coat to uniform appearance. Apply each coat of paint slightly darker than preceding coat unless specified otherwise.
- C. Sand metal surfaces lightly between coats to achieve required finish.

- D. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- E. Finishing Mechanical And Electrical Equipment:
 - 1. Refer to mechanical and electrical specifications for schedule of color coding and identification banding of equipment, duct work, piping, and conduit.
 - 2. Paint shop primed equipment. Paint shop finished items occurring at interior areas.
 - 3. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
 - 4. Prime and paint insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, equipment, brackets, collars and supports, except where items are shop finished.
 - 5. Paint exposed conduit and electrical equipment occurring in finished areas.
 - 6. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.4 FIELD QUALITY CONTROL

- A. Section 01 40 00 – Quality Requirements: Testing and Inspection Services.
- B. Inspect and test questionable coated areas.

3.5 CLEANING

- A. Section 01 70 00 – Execution and Closeout Requirements: Final cleaning.
- B. Collect waste material which may constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.6 SCHEDULE –EXTERIOR SURFACES – HIGH PERFORMANCE

- A. Shop Primed Ferrous Metal – Gloss Urethane:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. MAB Paints (Basis of Design)
 - 1) Bond Coat: One coat Rus-O-Lastic Universal Lacquer Resistant Primer 073, 2-3 mils dry film thickness.
 - 2) Finish: Two coats Ply-Thane 890 HS Coating 020, 3-4 mils dry film thickness per coat.
 - b. Sherwin-Williams:
 - 1) Bond Coat: One coat Kem Bond HS Primer B50, 2-5 mils dry film thickness.
 - 2) Finish: Two coats Hi-Solids Polyurethane B65, 3-4 mils dry film thickness per coat.
 - c. Benjamin Moore:
 - 1) Primer: One coat M-07 Universal Metal Primer; 2.0 mils dry film thickness.

- 2) Finish: Two coats M 74/75 Aliphatic Acrylic Urethane; 2.0 mils dry film thickness each coat.

d. Or equal as approved by the Professional

B. Ferrous Metals – Gloss Urethane:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

a. MAB Paints (Basis of Design):

- 1) Primer: One coat Ply-Tile 520-W-45 Epoxy Primer 011, 4-6 mils dry film thickness.
- 2) Finish: Two coats Ply-Thane 890 HS Coating 020, 3-4 mils dry film thickness.

b. Sherwin-Williams:

- 1) Primer: One coat Recoatable Epoxy Primer, 4-6 mils dry film thickness.
- 2) Finish: Two coats Hi-Solids Polyurethane B65, 3-4 mils dry film thickness per coat.

c. Benjamin Moore:

- 1) Primer: One coat M 33/34 Polyamide Epoxy Metal Primer; 2.0 mils dry film thickness.
- 2) Finish: Two coats M 74/75 Aliphatic Acrylic Urethane; 2.0 mils dry film thickness each coat.

d. Tnemec:

- 1) Primer: One coat Typoxy Series 27; 4-6 mils dry film thickness.
- 2) Finish: Two coats Endura-Shield Series 73; 3-4 mils dry film thickness per coat.

e. Or equal as approved by the Professional

C. Galvanized Metals – Gloss Urethane:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

a. MAB Paints (Basis of Design):

- 1) Primer: One coat Ply-Tile 520-W-45 Epoxy Primer 011, 4-6 mils dry film thickness.
- 2) Finish: Two coats Ply-Thane 890 HS Coating 020, 3-4 mils dry film thickness per coat.

b. Sherwin-Williams:

- 1) Primer: One coat Recoatable Epoxy primer, (B67), 4.0-6.0 mils dry film thickness.
- 2) Finish: Two coats Hi Solids Polyurethane B65, 3.0-4.0 mils dry film thickness per coat.

c. Benjamin Moore:

- 1) Primer: One coat M 33/34 Polyamide Epoxy Metal Primer; 2.0 mils dry film thickness.

- 2) Finish: Two coats M 74/75 Aliphatic Acrylic Urethane: 2.0 mils dry film thickness each coat.
- d. Tnemec:
 - 1) Primer: One coat Typoxy Series 27; 4-6 mils dry film thickness.
 - 2) Finish: Two coats Endura-Shield Series 73; 3-4 mils dry film thickness per coat.
- e. Or equal as approved by the Professional

3.7 SCHEDULE-INTERIOR SURFACES – HIGH PERFORMANCE

- A. Concrete, Floors – Gloss Epoxy
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. MAB Paints (Basis of Design):
 - 1) Finish: Two coats Ply-Tile 520 HB Epoxy, 3.0-6.0 mils dry film thickness.
 - b. Sherwin-Williams:
 - 1) Finish: Two coats Tile-Clad High Solids Epoxy, 2.5-4.0 mils dry film thickness each coat.
 - 2) Benjamin Moore:
 - 1) Finish: Two coats Corotech 100% Solids Epoxy, 2.0-3.0 mils dry film thickness each coat.
 - c. Or equal as approved by the Professional
 - 2. Broadcast manufacturer's recommended aggregate into coating for slip resistant finish. Coordinate with owner/engineer for required slip rating. Submit samples for approval.

3.8 PAINT SCHEDULE

- A. Paint all of the following: (Custom Color selection by Owner/Engineer. Assume a minimum of 10 different colors)
 - 1. All new equipment pads, tops and sides, and floor adjacent to the pads as to ensure the continuity of the coatings.
 - 2. Walls that are cut and patched for piping and/or equipment access.
 - 3. All new piping hangers, structural steel piping supports, and support structural attachments.
- B. Do not paint the following:
 - 1. Aluminum or stainless steel insulation jackets.
 - 2. Un-insulated stainless steel piping.
 - 3. PVC insulation and fitting jackets.
 - 4. Equipment identification labels, tags, or name plates.
 - 5. Foil faced insulation.
 - 6. Electrical switchgear, and panels.

END OF SECTION 200590

SECTION 21 05 00

COMMON WORK RESULTS FOR FIRE SUPPRESSION

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 pipe and fittings for sprinkler systems.

1.3 REFERENCES

- A. American Society of Mechanical Engineers:
 - 1. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
 - 2. ASME B16.11 - Forged Steel Fittings - Socket-Welding and Threaded.
 - 3. ASME B16.25 - Buttwelding Ends.
 - 4. ASME B16.3 - Malleable Iron Threaded Fittings.
 - 5. ASME B16.4 - Gray Iron Threaded Fittings.
 - 6. ASME B16.5 - Pipe Flanges and Flanged Fittings.
 - 7. ASME B16.9 - Factory-Made Wrought Steel Buttwelding Fittings.
 - 8. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.
- B. ASTM International:
 - 1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 2. ASTM A135 - Standard Specification for Electric-Resistance-Welded Steel Pipe.
 - 3. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
 - 4. ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
- C. American Welding Society:
 - 1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
 - 2. AWS D1.1 - Structural Welding Code - Steel.
- D. National Fire Protection Association:
 - 1. NFPA 13 - Installation of Sprinkler Systems.
- E. Underwriter Laboratories, Inc.:
 - 1. UL 1887 - Fire Tests of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

- B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, and floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
- C. Product Data: Submit manufacturers' catalogue information. Indicate valve data and ratings.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of components and tag numbering.
- C. Operation and Maintenance Data: Submit spare parts lists.

1.6 QUALITY ASSURANCE

- A. Provide fire sprinkler piping located in plenums with peak optical density not greater than 0.5, average optical density not greater than 0.15, and flame spread not greater than 5 feet (1.5 m) when tested in accordance with UL 1887.
- B. Perform Work in accordance with NFPA 13, Pennsylvania codes and MRA Standards.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Deliver and store valves in shipping containers, with labeling in place.
- C. Furnish cast iron and steel valves with temporary protective coating.
- D. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.9 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.1 ABOVE GROUND PIPING

- A. Steel Pipe: ASTM A53, threadable, Schedule 40 black.

1. Steel Fittings: ASME B16.11, forged steel socket welded and threaded.
2. Malleable Iron Fittings: ASME B16.3, threaded fittings, ASTM B47.
3. Mechanical Grooved Couplings: Victaulic FireLock EZ Rigid Coupling, Ductile iron conforming to ASTM A-536, grade 65-45-12, orange enamel, grade "E" EPDM (Type A), bolts and nuts shall be heat treated plated carbon steel, trackhead meeting the physical and chemical requirements of ASTM A-449 and the physical requirements of ASTM A-183.
4. Mechanical Formed Fittings: Victaulic FireLock Fittings, Ductile iron conforming to ASTM A-536, grade 65-45-12, orange enamel.

2.2 PIPE HANGERS AND SUPPORTS

- A. Conform to NFPA 13.
- B. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
- C. Hangers for Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
- D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- E. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.
- F. Wall Support for Pipe Sizes 4 inches and Over: Welded steel bracket and wrought steel clamp.
- G. Vertical Support: Steel riser clamp.
- H. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and foreign material, from inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- A. Install piping in accordance with NFPA 13 for sprinkler systems.
- B. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- C. Install piping to conserve building space, to not interfere with use of space and other work.
- D. Group piping whenever practical at common elevations.
- E. Install pipe sleeve at piping penetrations through partitions, walls, and floors. Seal pipe and sleeve penetrations to maintain fire resistance equivalent to fire separation.

- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Pipe Hangers and Supports:
 - 1. Install in accordance with NFPA 13.
 - 2. Install hangers to with minimum 1/2 inch space between finished covering and adjacent work.
 - 3. Place hangers within 12 inches of each horizontal elbow.
 - 4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
 - 6. Where installing several pipes in parallel and at same elevation, provide multiple or trapeze hangers.
 - 7. Prime coat exposed steel hangers and supports. [Refer to Section 09 90 00.] Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- H. Slope piping and arrange systems to drain at low points. Install eccentric reducers to maintain top of pipe level.
- I. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding. Refer to Section 09 90 00.
- J. Do not penetrate building structural members unless indicated.
- K. Where more than one piping system material is specified, install compatible system components and joints. Install flanges, union, and couplings at locations requiring servicing.
- L. Die cut threaded joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.
- M. Install valves with stems upright or horizontal, not inverted. Remove protective coatings prior to installation.
- N. Install gate valves for shut-off or isolating service.
- O. Install drain valves at main shut-off valves, low points of piping and apparatus.

3.3 INTERFACE WITH OTHER PRODUCTS

- A. Inserts:
 - 1. Install inserts for placement in concrete forms.
 - 2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Install hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

3.4 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Clean entire system after other construction is complete.

END OF SECTION 210500

SECTION 21 13 13

WET-PIPE SPRINKLER 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 sprinklers, system design, installation, and certification.
- B. Related Sections:
 - 1. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to equipment specified by this section.

1.3 REFERENCES

- A. National Fire Protection Association:
 - 1. NFPA 13 - Installation of Sprinkler Systems.

1.4 SYSTEM DESCRIPTION

- A. System to provide coverage for building areas indicated on the drawings.
- B. Provide hydraulically designed system to NFPA 13 ordinary hazard, Group 2 occupancy requirements.
- C. Determine volume and pressure of incoming water supply from water flow test data.
- D. Interface system with building fire alarm system.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate layout of finished ceiling areas indicating sprinkler locations coordinated with ceiling installation. Indicate detailed pipe layout, hangers and supports, sprinklers, components and accessories. Indicate system controls.
- C. Product Data: Submit data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- D. Design Data: Submit design calculations signed and sealed by professional engineer and NICET Level 3 technician.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.
- C. Operation and Maintenance Data: Submit components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

1.7 QUALITY ASSURANCE

- A. Perform Work in accordance with NFPA 13, Pennsylvania Codes, Factory Mutual, and MRA standards.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.9 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Store products in shipping containers until installation.
- C. Furnish piping with temporary inlet and outlet caps until installation.

PART 2 PRODUCTS

2.1 SPRINKLERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Viking (Basis of Design)
 - 2. Reliable
 - 3. Tyco
 - 4. Victaulic
 - 5. Or equal as approved by the Professional
- B. Concealed Type:
 - 1. Type: Concealed quick response pendant type with matching screw on escutcheon plate.

2. Escutcheon Plate Finish: Enamel, color as selected by Architect.
 3. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- C. Exposed Type:
1. Type: Quick response upright pendant type
 2. Fusible Link: Fusible solder link type temperature rated for specific area hazard.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with NFPA 13, Factory Mutual, Pennsylvania Codes, and MRA standards.
- B. Place pipe runs to minimize obstruction to other work.
- C. Install piping in concealed spaces above finished ceilings.
- D. Center sprinklers in two directions in ceiling tile and install piping offsets.
- E. Install and connect to fire pump system in accordance with NFPA 13.
- F. Install guards on sprinklers as indicated on Drawings and in all Mechanical Rooms.
- G. Hydrostatically test entire system.
- H. Require test be witnessed by Owner and Fire Marshall.

3.2 INTERFACE WITH OTHER PRODUCTS

- A. Verify signal devices are installed and connected to fire alarm system.

3.3 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Flush entire piping system of foreign matter.

3.4 PROTECTION OF INSTALLED CONSTRUCTION

- A. Section 01 70 00 - Execution and Closeout Requirements: Protecting installed construction.
- B. Apply masking tape or paper cover to protect concealed sprinklers, cover plates, and sprinkler escutcheons not receiving field paint finish. Remove after painting. Replace painted sprinklers with new.

END OF SECTION 211313

SECTION 22 05 03

PLUMBING 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 RELATED DOCUMENTS

- A. Applicable requirements of the Drawings, Owner/Contractor Agreement, General Conditions, Supplementary Conditions, Division 1 – General Requirements, and Owner Standards are part of this section and shall have the same force and effect as if printed herewith in full.

1.3 SECTION INCLUDES

- A. Domestic Water Piping, Above Grade
- B. Sanitary Waste and Vent Piping, Above Grade
- C. Sanitary Waste, Below Grade
- D. Roof Drain Piping, Above Grade
- E. Roof Drain Piping, Below Grade
- F. Flanges, Unions, and Couplings

1.4 RELATED SECTIONS

- A. Section 15015 - Basic Mechanical Requirements
- B. Section 15050 - Supports and Anchors.
- C. Section 15075 - Mechanical Identification.
- D. Section 15070 – Isolation and Seismic Controls.
- E. Section 15081 – Mechanical Insulation.

1.5 REFERENCES

- A. ANSI B31.1 - Power Piping.
- B. ANSI B31.9 - Building Service Piping.
- C. ASME - Boiler and Pressure Vessel Code.

- D. ASME Sec. 9 - Welding and Brazing Qualifications.
- E. ASME B16.1 - Cast Iron Pipe Flanges and Flange Fittings Class 25, 125, 250 and 800.
- F. ASME B16.3 - Malleable Iron Threaded Fittings.
- G. ASME B16.4 - Cast Iron Threaded Fittings Class 125 and 250.
- H. ASME B16.18 - Cast Bronze Solder-Joint Pressure Fittings.
- I. ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings
- J. ASME B16.23 - Cast Copper Alloy Solder-Joint Drainage Fittings - DWV.
- K. ASME B16.26 - Cast Bronze Fittings for Flared Copper Tubes.
- L. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
- M. ASME B16.32 - Cast Copper Alloy Solder-Joint Fittings for Solvent Drainage Systems.
- N. ASTM A47 - Ferritic Malleable Iron Castings.
- O. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- P. ASTM A74 - Cast Iron Soil Pipe and Fittings.
- Q. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- R. ASTM B32 - Solder Metal.
- S. ASTM B42 - Seamless Copper Pipe.
- T. ASTM B43 - Seamless Red Brass Pipe.
- U. ASTM B75 - Seamless Copper Tube.
- V. ASTM B88 - Seamless Copper Water Tube.
- W. ASTM B251 - Wrought Seamless Copper and Copper-Alloy Tube.
- X. ASTM B302 - Threadless Copper Pipe (TP).
- Y. ASTM B306 - Copper Drainage Tube (DWV).
- Z. ASTM C14 - Concrete Sewer, Storm Drain, and Culvert Pipe.
- AA. ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
- BB. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- CC. ASTM D2683 - Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe.

- DD. ASTM D4101 - Standard Classification System and Basis for Specification for Polypropylene Injection and Extrusion Materials.
- EE. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- FF. ASTM F845 - Plastic Insert Fittings for Polybutylene (PB) Pipe.
- GG. AWS A5.8 - Brazing Filler Metal.
- HH. AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.
- II. CISPI 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems.
- JJ. CISPI 310 - Joints for Hubless Cast Iron Sanitary Systems.
- KK. NCPWB - Procedure Specifications for Pipe Welding.

1.6 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

1.7 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01700.
- B. Record actual locations of valves.

1.8 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 01700.
- B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.9 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Welding Materials and Procedures: Conform to ASME Code
- C. Welders Certification: In accordance with ASME Sec 9.
- D. Maintain one copy of each document on site.

1.10 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing the work of this section with minimum 3 years documented experience.

1.11 REGULATORY REQUIREMENTS

- A. Perform Work in accordance with Lower Gwynedd plumbing code.

1.12 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 01600.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.13 EXTRA MATERIALS

- A. Furnish under provisions of Section 01700.
- B. Provide two repacking kits for each size valve.

PART 2 PRODUCTS

2.1 DOMESTIC WATER PIPING, ABOVE GRADE

- A. Refer To Plumbing Material Schedule On Sht. P000

2.2 SANITARY WASTE PIPING, BELOW GRADE

- A. Refer To Plumbing Material Schedule On Sht. P000

2.3 SANITARY WASTE AND VENT PIPING, ABOVE GRADE

- A. Refer To Plumbing Material Schedule On Sht. P000

2.4 ROOF DRAIN PIPING, BELOW GRADE

- A. Refer To Plumbing Material Schedule On Sht. P000

2.5 ROOF DRAIN PIPING, ABOVE GRADE

- B. Refer To Plumbing Material Schedule On Sht. P000

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide non-conducting dielectric connections wherever joining dissimilar metals.
- C. Route piping in orderly manner and maintain gradient.
- D. Install piping to conserve building space and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Provide clearance for installation of insulation and access to valves and fittings.
- H. Provide access where valves and fittings are not exposed.
- I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- J. Prepare pipe, fittings, supports, and accessories not prefinished, ready for finish painting. Refer to Section 09221.
- K. Install valves with stems upright or horizontal, not inverted.

3.3 APPLICATION

- A. Use grooved mechanical couplings and fasteners only in accessible locations.
- B. Install unions downstream of valves and at equipment or apparatus connections.
- C. Install brass male adapters each side of valves in copper piped system. Sweat solder adapters to pipe.
- D. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- E. Install ball valves for throttling, bypass, or manual flow control services.

3.4 ERECTION TOLERANCES

- A. Establish invert elevations, slopes for drainage to 1/4 inch per foot minimum. Maintain gradients.
- B. Slope water piping and arrange to drain at low points.

3.5 TESTING

- A. Domestic Water Piping – 4 hours at 100 psig
- B. Sanitary Waste Piping – 1 hour at 10 feet of water column.

- C. All other piping – 24 hours at 1.5 times the system operating pressure but not more than the system pressure rating.

3.6 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Prior to starting work, verify system is complete, flushed and clean.
- B. Ensure PH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
- D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
- E. Maintain disinfectant in system for 24 hours.
- F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
- G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
- H. Take samples no sooner than 24 hours after flushing, from 2 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

END OF SECTION 220503

SECTION 22 07 00

PLUMBING 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. Manufacturer
 - 2. Pipe Insulation
 - 3. Pipe Insulation Jackets
 - 4. Pipe Insulation Accessories
 - 5. Equipment Insulation
 - 6. Equipment Insulation Accessories
- B. Related Sections:
 - 1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
 - 2. Section 09 90 00 - Painting and Coating: Execution requirements for painting insulation jackets and covering specified by this section.
 - 3. Division 20 – All Sections.

1.3 REFERENCES

- A. ASTM International:
 - 1. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - 2. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
 - 3. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - 4. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
 - 5. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - 6. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
 - 7. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
 - 8. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 - 9. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
 - 10. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - 11. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
 - 12. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
 - 13. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.

14. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
15. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
16. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
17. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
18. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedule 40, 80, and 120.
19. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
20. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.
- C. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

- A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84.
- B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.
- C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.
- D. Perform Work in accordance with City of Philadelphia Codes.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three documented experience.
- B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.
- C. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.11 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Manufacturers; Glass Fiber and Mineral Fiber Insulation:
 - 1. Johns Manville
- B. Manufacturers; Closed Cell Elastomeric Insulation:
 - 1. Armacell AP Armaflex

2.2 PIPE INSULATION

- A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation.
 - 1. Thermal Conductivity: 0.23 at 75 degrees F.
 - 2. Operating Temperature Range: 0 to 850 degrees F.
 - 3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
 - 4. Jacket Temperature Limit: minus 20 to 150 degrees F.

2.3 PIPE INSULATION JACKETS

- A. PVC Plastic Pipe Jacket:
 - 1. Manufacturer: Proto Corp.LoSmoke
 - 2. Product Description: ASTM C921, rolled sheet material suitable for field painting. Custom color selection from manufacturers color chart.
 - 3. Thickness: 30 mil.
 - 4. Connections: Pressure sensitive color matching tape.
 - 5. Fittings:

2.4 PIPE INSULATION ACCESSORIES

- A. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.
- B. Piping 2 inches diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.

2.5 EQUIPMENT INSULATION

- A. TYPE E-1: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet.
 - 1. Thermal Conductivity: 0.27 at 75 degrees F.
 - 2. Operating Temperature Range: Range: Minus 70 to 220 degrees F.

2.6 EQUIPMENT INSULATION ACCESSORIES

- A. Vapor Retarder Lap Adhesive: Compatible with insulation.
- B. Covering Adhesive Mastic: Compatible with insulation

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify piping and equipment has been tested before applying insulation materials.
- C. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

- A. Locate insulation and cover seams in least visible locations.
- B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 07 84 00 for penetrations of assemblies with fire resistance rating greater than one hour.
- C. Piping Systems Conveying Fluids Below Ambient Temperature:
 - 1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
 - 2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
 - 3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish PVC jacketing.
- D. Inserts and Shields:
 - 1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.

2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.
 - a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
 - b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
 3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.
- E. Roof Drain and Overflow Drain Bodies:
1. Insulate all bodies with 1" thick continuous insulation sealed to piping connections.
- F. Closed Cell Elastomeric Insulation:
1. Push insulation on to piping.
 2. Miter joints at elbows.
 3. Seal seams and butt joints with manufacturer's recommended adhesive.
 4. When application requires multiple layers, apply with joints staggered.
 5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.
- G. Prepare pipe insulation and jacketing for finish painting. Refer to Section 09 90 00.

3.3 SCHEDULES

A. Water Supply Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches
Domestic Water	P-1	1 inch and smaller	1.0
		1-1/4 inches to 2 inches	1.5
		2-1/2 inches and larger	2.0
Storm Sewer Abv. Grd.	P-1	All Pipe sizes	1.5

END OF SECTION 220700

SECTION 22 11 00

FACILITY WATER 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 SUMMARY

- A. Section Includes:
 - 1. Non-potable water piping, above grade.
 - 2. Flanges, unions and couplings
 - 3. Valves.
 - 4. Thermometers
 - 5. Pipe hangers and supports.
 - 6. Pressure gages.
 - 7. Pressure gage taps.
 - 8. Backflow preventers.
- B. Related Sections:
 - 9. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for placement of concrete housekeeping pads specified by this section.
 - 10. Section 09 96 00 - Painting and Coating: Product and execution requirements for painting specified by this section.
 - 11. Division 20 – All Sections.
 - 12. Section 22 07 00 - Plumbing Insulation: Product and execution requirements for pipe insulation.
 - 13. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to equipment specified by this section.

1.3 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI Z21.22 - Relief Valves for Hot Water Supply Systems.
- B. American Society of Mechanical Engineers:
 - 1. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
 - 2. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - 3. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
 - 4. ASME B31.9 - Building Services Piping.
 - 5. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.
 - 6. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.
 - 7. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.
- C. American Society of Sanitary Engineering:
 - 1. ASSE 1010 - Performance Requirements for Water Hammer Arresters.
 - 2. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers.
 - 3. ASSE 1012 - Performance Requirements for Backflow Preventer with Intermediate Atmospheric Vent.
 - 4. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers.

5. ASSE 1019 - Performance Requirements for Vacuum Breaker Wall Hydrants, Freeze Resistant, Automatic Draining Type.
 6. ASSE 5013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers (RP) and Reduced Pressure Fire Protection Principle Backflow Preventers (RFP).
 7. ASSE 5015 - Performance Requirements for Testing Double Check Backflow Prevention Assemblies (DC) and Double Check Fire Protection Backflow Prevention Assemblies (RPDF).
- D. ASTM International:
1. ASTM B32 - Standard Specification for Solder Metal.
 2. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes.
 3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
 4. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
- E. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
- F. American Water Works Association:
1. AWWA C104 - American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
 2. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
 3. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
 4. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 5. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
 6. AWWA C651 - Disinfecting Water Mains.
- G. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
 2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
 3. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
 4. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
 5. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
 6. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
 7. MSS SP 85 - Cast Iron Globe & Angle Valves, Flanged and Threaded.
 8. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
 9. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
- H. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- I. Plumbing and Drainage Institute:
1. PDI WH201 - Water Hammer Arrester Standard.
- J. Underwriters Laboratories Inc.:
1. UL 393 - Indicating Pressure Gauges for Fire-Protection Service.
 2. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service.
 - 3.

1.4 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacture, assembly, and field performance of pumps with minimum three years experience.
- B. Alignment: Base mounted pumps shall be aligned by qualified millwright.
- C. Valves: Manufacturer's name and pressure rating marked on valve body.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data:
 - 1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturer's catalog information.
 - 2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
 - 3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
 - 4. Domestic Water Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.
 - 5. Pumps: Submit certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include motor, electrical characteristics and connection requirements. Submit also, manufacturer model number, materials, dimensions, service sizes, and finishes. Submit grounding rings where applicable. Manufacturer's Installation Instructions: Submit installation instructions for pumps, valves and accessories.

- C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
 - D. Submit manufacturer's installation instructions under provisions of Division 01.
 - E. Millwright's Certificate: Certify that base mounted pumps have been aligned.
- 1.6 OPERATION AND MAINTENANCE DATA
- A. Submit operation and maintenance data under provisions of Division 01.
 - B. Include installation instructions, assembly views, lubrication instructions, and replacement parts list.
- 1.7 CLOSEOUT SUBMITTALS
- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
 - B. Project Record Documents: Record actual locations of valves and equipment.
 - C. Operation and Maintenance Data: Submit spare parts list, exploded assembly views and recommended maintenance intervals.
- 1.8 QUALIFICATIONS
- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience and with service facilities within 50 miles of Project.
 - B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.
- 1.9 PRE-INSTALLATION MEETINGS
- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
 - B. Convene minimum one week prior to commencing work of this section.
- 1.10 DELIVERY, STORAGE, AND HANDLING
- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
 - B. Accept valves and equipment on site in shipping containers with labeling in place. Inspect for damage.
 - C. Provide temporary protective coating on cast iron and steel valves.
 - D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
 - E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.
- 1.11 ENVIRONMENTAL REQUIREMENTS
- A. Section 01 60 00 - Product Requirements.
 - B. Do not install underground piping when bedding is wet or frozen.
- 1.12 FIELD MEASUREMENTS
- A. Verify field measurements prior to fabrication.

1.13 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for pressure boosting system.

1.14 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Provide one set of mechanical seals for each pump.

1.15 REGULATORY REQUIREMENTS

- A. Perform Work in accordance with State of Maryland and the Building Fire and Related Codes of Baltimore City, latest edition.

PART 2 PRODUCTS

2.1 POTABLE & NON-POTABLE WATER PIPING, ABOVE GRADE

- A. 3" and Smaller
 - 1. Tubing to be Type L hard temper with wrought copper fittings conforming to ASTM B88-and ASME B16.22. All joints shall be soldered with ASTM B32 lead free solder.
- B. Larger than 3"
 - 1. Stainless Steel Pipe: 304L, ASTM A312, ASTM A790, Schedule 10, seamless.
 - 2. Fittings: ASTM A403, ASTM A960, MSS SP-43 butt weld fittings
 - a. Joints AWS D1.1, welded

2.2 FLANGES, UNIONS, AND COUPLINGS

- A. Unions for Pipe 3" and Smaller:
 - 1. Wrought Copper unions
 - 2. Dielectric Connections: Refer to Section 20 00 01.
- B. Flanges for Larger than 3":
 - 1. ASTM A182, TP304L, ASME B16.5, 150 psig forged stainless steel, weld neck.
 - 2. Gaskets: one-piece, compressed compound fiber type, $\frac{1}{16}$ inch thick
- C. Dielectric Connections:
 - 1. Unions with carbon steel threaded end, copper threaded end, and/or stainless steel threaded end water impervious isolation barrier, identical to sure seal o-ring unions as manufactured by Hart. Material to be selected based on jointing pipe materials. Refer to Section 20 00 01.
 - 2.
 - 3. Flange isolating kits with nitrile duplex-seal Trojan gasket, minlon isolating sleeves, flange protectors, double washers, and protection caps as manufactured by Advance Products and Systems, Inc. Materials contractor shall engage the services of the piping and corrosion company. Refer to Section 20 00 01.

2.3 BALL VALVES

- A. Up to and including 2 inches: Class 600
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Apollo (Basis of Design)

- b. Milwaukee Valves and Fittings
- c. Watts
- d. Or equal as approved by the Professional

- 2. Full ported stainless steel three-piece body, stainless steel ball and stem, extended stem, RPTFE seats, threaded ends.

2.4 PIPE HANGERS AND SUPPORTS

- A. Plumbing Piping: Conform to ASME B31.9
- B. Copper Pipe Support: Carbon steel ring, adjustable, copper plate.

2.5 THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Noshok, Inc. Series 320 (Basis of Design)
 - 2. Dwyer
 - 3. Watts
 - 4. Or equal as approved by the Professional
- B. 5 inch diameter scale, 304 stainless case with electric polished 304 stainless steel bezel, black aluminum pointer, 304 stainless steel stems, adjustable angle connection. Accuracy shall be $\pm 1\%$ of full scale. Scale shall be 0-100°F. Stem size shall be nearest to $\frac{1}{2}$ inch diameter of pipe.
- B. Provide Lead-free thermowell, fully filled with thermowell grease prior to stem insertion.

2.6 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Noshok, Inc. Series 300 (Basis of Design)
 - 2. Dwyer
 - 3. Watts
 - 4. Or equal as approved by the Professional
- B. ASME B40.1, 4½ inch diameter die cast brass case, phosphor bronze bourdon tube, brass and nickel silver movement, brass socket, black scale on white background, one percent full scale accuracy, scale calibrated in psi, glycerine filled.

2.7 PRESSURE GAGE TAPS

- A. Needle Valve: Stainless Steel, 1/4 inch NPT for minimum 300 psi.
- B. Ball Valve: Per Article 2.6 above.
- C. Pulsation Damper: Pressure snubber, stainless steel with 1/4 inch NPT connections.
- D. Lead Free

2.8 BACKFLOW PREVENTERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Watts Model LF-909 (Basis of Design)
 - 2. Zurn
 - 3. Apollo
 - 4. Or equal as approved by the Professional.
- B. A Reduced Pressure Zone Assembly shall be installed at each cross-connection to prevent back-siphonage and backpressure backflow of hazardous materials into the potable water supply. The assembly shall consist of a pressure differential relief valve located in a zone between two positive seating check valves and captured springs. Back-siphonage protection shall include provision to admit air directly into the reduced pressure zone via a separate channel from the water discharge channel. The assembly shall include two tightly closing shutoff valves before and after the valve and test cocks. The Lead Free* Reduced Pressure Zone Assembly shall comply with state codes and standards, where applicable, requiring reduced lead content. The assembly shall meet the requirements of ASSE Std. 1013; AWWA Std. C511-92; CSA B64.5; and UL Classified File No. EX3185. Listed by IAPMO (UPC). Approved by the Foundation for Cross-Connection Control and Hydraulic Research at the University of Southern California. The assembly shall be a Watts Series LF909.
- C. Provide with Watts QT-FDA line-size FDA epoxy coated quarter-turn ball valves.
- D. Provide with Watts S-FDA line-size FDA epoxy coated strainer.
- E. Provide with Watts 909AG-K air gap.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Carbon steel wire brushes or chipping hammers shall not be used on stainless steel materials.
- C. Remove scale and dirt, on inside and outside, before assembly.
- D. Prepare piping connections to equipment with flanges or unions.
- E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps
- F. After completion, fill, clean, and treat systems. Refer to section 23 25 00

3.3 INSTALLATION - GAGES

- A. Install one pressure gage for each pump, locate taps before strainers/suction diffusers and on suction and discharge of pump; pipe to gage.
- B. Install gage taps in piping.
- C. Install pressure gages with pulsation dampers. Provide needle valve to isolate each gage.
- D. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- E. Install gages in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- F. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.4 INSTALLATION - HANGERS AND SUPPORTS

- A. Pipe Hangers and Supports:
 - 1. Install in accordance with [ASME B31.9.
 - 2. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 3. Place hangers within 12 inches of each horizontal elbow.
 - 4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
 - 6. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
 - 7. Provide copper plated hangers and supports for copper piping.
 - 8. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00.
 - 9. Provide hangers adjacent to motor driven equipment with vibration isolation; refer to Section 21 05 48.

3.5 INSTALLATION - ABOVE GROUND PIPING AND SPECIALTIES

- A. Install in accordance with the manufacturer's instructions.
- B. Install non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- D. Install piping to maintain headroom without interfering with use of space or taking more space than necessary.
- E. Group piping whenever practical at common elevations.
- F. Slope piping and arrange systems to drain at low points.
- G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 21 05 16.

- H. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 07 00.
- I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- J. Provide support for meters in accordance with requirements of utility companies.
- K. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09 96 00.
- L. Install domestic water piping in accordance with ASME B31.9.
- M. Sleeve pipes passing through partitions, walls and floors. Refer to Section 22 05 29.
- N. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping.
- O. Install unions downstream of valves and at equipment or apparatus connections.
- P. Install valves with stems upright or horizontal, not inverted.
- Q. Install gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- R. Provide spring loaded check valves on discharge of water pumps.
- S. Install potable water protection devices on plumbing lines where indicated on the drawings.
- T. Test backflow preventers in accordance with ASSE.
- U. Pipe relief from back flow preventer to nearest drain.
- V. Install Work in accordance with the City of Baltimore and State of Maryland Codes.
- W. Confirm deck and insulation thickness and select properly sized adjustable collar to match insulation thickness.

3.6 INSTALLATION - SERVICE CONNECTIONS

- A. Provide connection to existing water service with approved reduced pressure double check back-flow preventer and water meter with strainer.

3.7 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements and 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Test domestic water piping system in accordance with the International Plumbing Code and ASME 31.9 to 250 PSIG for 4 hours. CM and Owner to witness testing. Submit report of completed test within 2 days of testing. Send copies to Owner, CM, Commissioning Agent, and A/E.
- C. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

- D. Prior to starting work, verify system is complete, flushed and clean.
- E. Verify pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- F. Inject disinfectant, free chlorine in liquid, powder and tablet or gas form, throughout system to obtain residual from 50 to 80 mg/L.
- G. Bleed water from outlets to obtain distribution and test for disinfectant residual at minimum 15 percent of outlets.
- H. Maintain disinfectant in system for 24 hours.
- I. When final disinfectant residual tests less than 25 mg/L, repeat treatment.
- J. Flush disinfectant from system until residual concentration is equal to incoming water or 1.0 mg/L.
- K. Take samples no sooner than 24 hours after flushing, from outlets and from water entry, and analyze in accordance with AWWA C651.

3.8 ERECTION TOLERANCES

- A. Establish invert elevations, slopes for drainage to 1/4 inch per foot minimum. Maintain gradients.
- B. Slope water piping and arrange to drain at low points.
- C. TESTING

- A. After completion of the piping installation and prior to initial operation, conduct tests on the piping system. Provide materials and equipment required for tests. Correct defects disclosed by the test. Perform test after installation and in the presence of the Owner's Representative. Give 5 days notice prior to scheduling the tests. All costs associated with the testing shall be paid for by the Contractor, including all testing agency fees.

B. Plumbing Piping:

- 1. Hydrostatically test in accordance with the requirements of ANSI B31.9. Test piping system at one and one-half times system pressure but at least 150 psig with water not exceeding 200°F. Before tests, remove or isolate gauges, pumps, and other apparatus in the system that may be damaged. Repair leaks tightening or re-welding joints, or renewing pipe or fittings. Do not calk joints. Install a calibrated, test pressure gauge in the system to observe loss in pressure. Maintain the required test pressure for a minimum of 24 hours to enable an inspection of joints and connections. Correct defects disclosed by the test.

END OF SECTION 221100

SECTION 22 11 19
PLUMBING SPECIALTIES

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 SECTION INCLUDES

- A. Backflow preventers
- B. Hose-Bibb Mechanical Rooms

1.03 RELATED SECTIONS

- A. General Conditions of the Construction Contract.
- B. Division 1 – All Sections.
- C. Section 20 05 00 – General Requirements.
- D. Section 23 05 00 – General Requirements Mechanical.
- E. Section 20 05 31 – Common Supports and Anchors.
- F. Section 20 05 53 –Identification.
- G. Section 23 07 09 – Piping Insulation.
- H. Section 22 11 00 - Plumbing Piping.
- I. Section 23 08 00 – Commissioning.

1.04 REFERENCES

- A. ANSI/ASSE 1011 - Hose Connection Vacuum Breakers.
- B. ANSI/ASSE 1012 - Backflow Preventers with Immediate Atmospheric Vent.
- C. ANSI/ASSE 1013 - Backflow Preventers, Reduced Pressure Principle.
- D. ANSI/ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types.
- E. ANSI A112.21.1 - Floor Drains.
- F. ANSI A112.21.2 - Roof Drains.
- G. ANSI A112.26.1 - Water Hammer Arrestors.
- H. ASTM C478 - Precast Reinforced Concrete Manhole Sections.

- I. AWWA C506 - Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types.
- J. PDI WH-201 Water Hammer Arresters.

1.05 SUBMITTALS

- A. Submit under provisions of Division 1.
- B. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.
- C. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
- D. Manufacturer's Installation Instructions: Indicate assembly and support requirements.

1.06 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 1.
- B. Record actual locations of plumbing specialties.

1.07 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 1.
- B. Operation Data: Indicate frequency of treatment required for interceptors.
- C. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 1.
- B. Accept specialties on site in original factory packaging. Inspect for damage.

1.09 EXTRA MATERIALS

- A. Furnish under provisions of Division 1.
- B. Provide two loose keys hose end vacuum breakers service kits for backflow preventers and water hammer arresters.

PART 2 PRODUCTS

2.01 BACKFLOW PREVENTERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Watts 909RW (Basis of Design)
 - 2. Zurn
 - 3. Apollo/Conbraco
 - 4. Or equal as approved by the Professional

B. Domestic Water Service (2-1/2" and above):

1. Reduced Pressure Backflow Preventers: ANSI/ASSE 1013, AWWA C506; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; non-threaded vent outlet; assembled with two gate valves, and four test cocks; Model 909RW, manufactured by Watts.

2.02 HOSE BIBB (HB) - Mechanical Rooms

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

1. Nibco QTX (Basis)
2. Zurn
3. Watts
4. Jay R. Smith
5. Or equal as approved by the Professional

- B. 3/4" Quarter-Turn Hose-Bibb
- C. Screw – Steel
- D. I.D. Tag – Aluminum
- E. Handle – Zinc
- F. Stem – Brass ASTM B 16
- G. O-Ring – Nitrile Seat PTFE
- H. Ball – Brass ASTM B 16
- I. Adapter – Brass ASTM B 283
- J. Body – Brass ASTM B 283

PART 3 EXECUTION

3.01 PREPARATION

- A. Coordinate cutting and forming of roof and floor construction to receive drains to required invert elevations.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
- C. Encase exterior cleanouts in concrete flush with grade.
- D. Pipe relief from back flow preventer to nearest drain.
- E. Install water hammer arrestors complete with accessible isolation valve.

END OF SECTION 221119

SECTION 22 13 00

FACILITY SANITARY SEWERAGE

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. Sanitary sewer piping buried within 5 feet of building.
2. Sanitary sewer piping above grade.
3. Unions and flanges.

B. Related Sections:

1. Section 033000 - Cast-In-Place Concrete: Execution requirements for placement of concrete specified by this section.
2. Section 078400 - Firestopping: Product requirements for firestopping for placement by this section.
3. Section 083113 - Access Doors and Frames: Product requirements for access doors for placement by this section.
4. Section 099000 - Painting and Coating: Product and execution requirements for painting specified by this section.
5. Section 220503 - Pipes and Tubes for Plumbing Piping and Equipment: Product and installation requirements for piping materials applying to various system types.
6. Section 220513 - Common Motor Requirements for Plumbing Equipment: Product requirements for motors for placement by this section.
7. Section 220516 - Expansion Fittings and Loops for Plumbing Piping: Execution requirements for pipe expansion devices for placement by this section.
8. Section 220523 - General-Duty Valves for Plumbing Piping: Product requirements for valves for placement by this section.
9. Section 220529 - Hangers and Supports for Plumbing Piping and Equipment: Product requirements for pipe hangers and supports and firestopping for placement by this section.
10. Section 220548 - Vibration and Seismic Controls for Plumbing Piping and Equipment: Product requirements for vibration isolators for placement by this section.
11. Section 220553 - Identification for Plumbing Piping and Equipment: Product requirements for pipe identification for placement by this section.
12. Section 220700 - Plumbing Insulation: Product and execution requirements for pipe insulation.
13. Section 260503 - Equipment Wiring Connections: Execution requirements for electric connections to equipment specified by this section.
14. Section 310513 - Soils for Earthwork: Soils for backfill in trenches.
15. Section 310516 - Aggregates for Earthwork: Aggregate for backfill in trenches.
16. Section 312316 - Excavation: Product and execution requirements for excavation and backfill required by this section.

17. Section 312316.13 - Trenching: Execution requirements for trenching required by this section.
18. Section 312323 - Fill: Requirements for backfill to be placed by this section.
19. Section 334100 - Storm Utility Drainage Piping: Catch basins and manholes.

1.3 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME A112.14.1 - Backwater Valves.
2. ASME A112.14.3 - Grease Interceptors.
3. ASME A112.14.4 - Grease Removal Devices.
4. ASME A112.21.1 - Floor Drains.
5. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
6. ASME B16.3 - Malleable Iron Threaded Fittings.
7. ASME B16.4 - Gray Iron Threaded Fittings.
8. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings (DWV).
9. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
10. ASME B31.9 - Building Services Piping.

B. ASTM International:

1. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.
2. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
3. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
4. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
5. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
6. ASTM A536 - Standard Specification for Ductile Iron Castings.
7. ASTM B32 - Standard Specification for Solder Metal.
8. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes.
9. ASTM B43 - Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
10. ASTM B75 - Standard Specification for Seamless Copper Tube.
11. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
12. ASTM B251 - Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
13. ASTM B302 - Standard Specification for Threadless Copper Pipe, Standard Sizes.
14. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV).
15. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
16. ASTM C1053 - Standard Specification for Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications.
17. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
18. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
19. ASTM D2241 - Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Inside Diameter.
20. ASTM D2464 - Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

21. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
22. ASTM D2467 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
23. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
24. ASTM D2661 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
25. ASTM D2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
26. ASTM D2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
27. ASTM D2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
28. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
29. ASTM D2996 - Standard Specification for Filament-Wound Fiberglass (Glass-Fiber-Reinforced Thermosetting Resin) Pipe.
30. ASTM D2997 - Standard Specification for Centrifugally Cast Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
31. ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
32. ASTM D3262 - Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe.
33. ASTM D3517 - Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe.
34. ASTM D3754 - Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe.
35. ASTM D3840 - Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Fittings for Nonpressure Applications.
36. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
37. ASTM F628 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe with a Cellular Core.
38. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
39. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

C. Cast Iron Soil Pipe Institute:

1. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
2. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.

D. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
4. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
5. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
6. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
7. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

E. Plumbing and Drainage Institute:

1. PDI G101 - Standard - Testing and Rating Procedure for Grease Interceptors.

1.4 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes for sewage-ejectors, and manholes.

C. Product Data:

1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
4. Sanitary Drainage Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.
5. Pumps: Submit pump type, capacity, certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.

D. Manufacturer's Installation Instructions: Submit installation instructions for material and equipment.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of equipment and clean-outs.

C. Operation and Maintenance Data: Submit frequency of treatment required for interceptors. Include, spare parts lists, exploded assembly views for pumps and equipment.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with Pennsylvania, Horsham Township standards.

B. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.8 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Product storage and handling requirements.
- B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Section 016000 - Product Requirements.
- B. Do not install underground piping when bedding is wet or frozen.

1.11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.12 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five-year manufacturer warranty.

PART 2 - PRODUCTS

2.1 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Cast Iron Soil Pipe: ASTM A74, service weight, bell and spigot ends.
 - 1. Fittings: Cast iron, ASTM A74.
 - 2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.
- B. Cast Iron Pipe: CISPI 301, hub-less.
 - 1. Fittings: Cast iron, CISPI 301.
 - 2. Joints: CISPI 310, neoprene gasket and stainless steel clamp and shield assemblies.

2.2 SANITARY SEWER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: ASTM A74, service weight.
 - 1. Fittings: Cast iron, ASTM A74.
 - 2. Joints: ASTM C564, rubber gasket joint devices or lead and oakum.
- B. Cast Iron Pipe: CISPI 301, hub-less, service weight.
 - 1. Fittings: Cast iron, CISPI 301.
 - 2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.
- C. Copper Tube: ASTM B306, DWV ASTM B75 ASTM B88 ASTM B251 Type [K] [L] [M].
 - 1. Fittings: ASME B16.23, cast bronze, or ASME B16.29, wrought copper.
 - 2. Joints: ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, [lead free] solder.

2.3 UNIONS AND FLANGES

- A. Unions for Pipe 2 inches and Smaller:
 - 1. Copper Piping: Class 150, bronze unions with soldered joints.
 - 2. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
 - 3. PVC Piping: PVC.
- B. Flanges for Pipe 2-1/2 inches and Larger:
 - 1. Copper Piping: Class 150, slip-on bronze flanges.
 - 2. PVC Piping: PVC flanges.
 - 3. Gaskets: 1/16 inch thick preformed neoprene gaskets.
- C. PVC Pipe Materials: For connections to equipment and valves with threaded connections, furnish solvent-weld socket to screwed joint adapters and unions, or ASTM D2464, Schedule 80, threaded, PVC pipe.

2.4 PIPE HANGERS AND SUPPORTS

- A. Per Section 20 05 31.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - HANGERS AND SUPPORTS

- A. Inserts:
 - 1. Provide inserts for placement in concrete forms.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.
- B. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9 ASTM F708 and MSS SP 89.
 - 2. Support horizontal piping as scheduled.
 - 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches of each horizontal elbow.
 - 5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 6. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
 - 7. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.
 - 8. Provide copper plated hangers and supports for copper piping.
 - 9. Prime coat exposed steel hangers and supports. Refer to Section 099000. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
 - 10. Install hangers adjacent to motor driven equipment with vibration isolation; refer to Section 210548.

3.4 INSTALLATION - BURIED PIPING SYSTEMS

- A. Verify connection to existing piping system, size, location, and invert are as indicated on Drawings.
- B. Establish elevations of buried piping with not less than 3 ft of cover.
- C. Establish minimum separation of 6' from other services water service piping in accordance with IPC 2018 code.

- D. Remove scale and dirt on inside of piping before assembly.
- E. Excavate pipe trench in accordance with Section 312316.
- F. Install pipe to elevation as indicated on Drawings.
- G. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding 4 inches compacted depth; compact to 95 percent maximum density.
- H. Install pipe on prepared bedding.
- I. Route pipe in straight line.
- J. Pipe Cover and Backfilling:
 - 1. Backfill trench in accordance with Section 312323.
 - 2. Maintain optimum moisture content of fill material to attain required compaction density.
 - 3. After hydrostatic test, evenly backfill entire trench width by hand placing backfill material and hand tamping in 6 inches compacted layers to 6 inches minimum cover over top of jacket. Compact to 95 percent maximum density.
 - 4. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
 - 5. Do not use wheeled or tracked vehicles for tamping.

3.5 INSTALLATION - ABOVE GROUND PIPING

- A. Establish invert elevations, slopes for drainage to 1/8 inch per foot minimum. Maintain gradients.
- B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Provide clearances at cleanout for snaking drainage system.
- C. Encase exterior cleanouts in concrete flush with grade.
- D. Install floor cleanouts at elevation to accommodate finished floor.
- E. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- F. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- G. Install piping to maintain headroom. Do not spread piping, conserve space.
- H. Group piping whenever practical at common elevations.
- I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 210516.
- J. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 220700.
- K. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Section 083113.

- L. Install piping penetrating roofed areas to maintain integrity of roof assembly.
- M. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- N. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 099000.
- O. Install bell and spigot pipe with bell end upstream.
- P. Sleeve pipes passing through partitions, walls and floors.
- Q. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping. Refer to Section 078400.
- R. Support cast iron drainage piping at every joint.

3.6 SCHEDULES

A. Pipe Hanger Spacing:

- 1. Pipe Material: Cast iron.
 - a. Maximum Hanger Spacing: 5 feet.
 - b. Hanger Rod Diameter: 5/8 inch.
- 2. Pipe Material: Cast iron, with 10-foot (3-m) length of pipe.
 - a. Maximum Hanger Spacing: 10 feet.
 - b. Hanger Rod Diameter: 5/8 inch.
- 3. Pipe Material: Copper tube.
 - a. Size: 1-1/4 inches and smaller.
 - b. Maximum Hanger Spacing: 6 feet.
 - c. Hanger Rod Diameter: 1/2 inch.
- 4. Pipe Material: Copper tube.
 - a. Size: 1-1/2 inches and larger.
 - b. Maximum Hanger Spacing: 10 feet.
 - c. Hanger Rod Diameter: 1/2 inch.

END OF SECTION 221300

SECTION 22 14 00

FACILITY STORM DRAINAGE

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. Storm water piping buried within 5 feet of building.
2. Storm water piping above grade.
3. Unions and flanges.
4. Valves.
5. Pipe hangers and supports.
6. Roof drains.

B. Related Sections:

1. Section 033000 - Cast-in-Place Concrete: Execution requirements for placement of concrete specified by this section.
2. Section 078400 - Firestopping: Product requirements for firestopping for placement by this section.
3. Section 083113 - Access Doors and Frames: Product requirements for access doors for placement by this section.
4. Section 099000 - Painting and Coating: Execution requirements for painting material specified by this section.
5. Section 220503 - Pipes and Tubes for Plumbing Piping and Equipment: Product and installation requirements for piping materials applying to various system types.
6. Section 200529 - Hangers and Supports for Plumbing Piping and Equipment: Product requirements for pipe hangers and supports and firestopping for placement by this section.
7. Section 200530 - Vibration and Seismic Controls for Plumbing Piping and Equipment: Product requirements for vibration isolators for placement by this section.
8. Section 200553 - Identification for Plumbing Piping and Equipment: Product requirements for pipe identification for placement by this section.
9. Section 220700 - Plumbing Insulation: Product and execution requirements for pipe insulation.
10. Section 260503 - Equipment Wiring Connections: Execution requirements for electric connections to equipment specified by this section.
11. Section 310513 - Soils for Earthwork: Soils for backfill in trenches.
12. Section 310516 - Aggregates for Earthwork: Aggregate for backfill in trenches.
13. Section 312316 - Excavation: Product and execution requirements for excavation and backfill required by this section.
14. Section 312316.13 - Trenching: Execution requirements for trenching required by this section.
15. Section 312323 - Fill: Requirements for backfill to be placed by this section.

1.3 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME A112.21.1M - Floor Drains.
2. ASME A112.21.2M - Roof Drains.
3. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings (DWV).
4. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
5. ASME B31.9 - Building Services Piping.

B. ASTM International:

1. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
2. ASTM B32 - Standard Specification for Solder Metal.
3. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV).
4. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
5. ASTM C700 - Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
6. ASTM D1785 - Standard Specification for (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
7. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
8. ASTM D2464 - Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
9. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
10. ASTM D2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
11. ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
12. ASTM D2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
13. ASTM D2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
14. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
15. ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
16. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
17. ASTM F679 - Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
18. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

C. Cast Iron Soil Pipe Institute:

1. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
2. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.

D. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
4. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
5. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
6. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
7. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.4 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes for sump-pumps, catch basins and manholes.
- C. Product Data:
 1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
 2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
 3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
 4. Storm Drainage Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.
 5. Pumps: Submit pump type, capacity, certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Submit installation instructions for material and equipment.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of equipment and cleanouts.
- C. Operation and Maintenance Data: Submit spare parts lists, exploded assembly views for pumps and equipment.

1.6 QUALITY ASSURANCE

- A. Perform Work according to Pennsylvania, Horsham Township standard.
- B. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years' documented experience and approved by manufacturer.

1.8 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Product storage and handling requirements.
- B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Section 016000 - Product Requirements.
- B. Do not install underground piping when bedding is wet or frozen.

1.11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.12 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 - PRODUCTS

2.1 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Cast Iron Pipe: ASTM A74, extra heavy bell and spigot ends.
 - 1. Fittings: Cast iron, ASTM A74.
 - 2. Joints: ASTM C564, rubber gasket joint devices or lead and oakum.

2.2 STORM WATER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: ASTM A74 service plain ends.
 - 1. Fittings: Cast iron, ASTM A74.
 - 2. Joints: ASTM C564, neoprene gasket system.
- B. Cast Iron Pipe: CISPI 301, hubless, service weight.
 - 1. Fittings: Cast iron, CISPI 301.
 - 2. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies.

2.3 PIPE HANGERS AND SUPPORTS

- A. Per 20 05 29 – Hangers and Supports.

2.4 ROOF DRAINS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Josam 22080-Q5 Primary and Overflow Combination (Basis of Design)
 - 2. Zurn
 - 3. Jay R. Smith
 - 4. Or equal as approved by the Professional
- B. Roof Drain (RD-1):
 - 1. Assembly: ASME A112.21.2M.
 - 2. Body: Lacquered cast iron with sump.
 - 3. Strainer: Removable cast iron dome.
 - 4. Accessories: Coordinate with roofing type, refer to associated section.
 - a. 4" Pipe size.
 - b. Membrane flange and membrane clamp with integral gravel stop.
 - c. Adjustable under deck clamp.
 - d. Roof sump receiver.
 - e. Waterproofing flange.
 - f. Controlled flow weir.
 - g. Leveling frame.
 - h. Adjustable extension sleeve for roof insulation.
 - i. Perforated or slotted ballast guard extension for inverted roof.
 - j. Perforated stainless steel ballast guard extension.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.

- B. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - HANGERS AND SUPPORTS

- A. Inserts:
 - 1. Provide inserts for placement in concrete forms.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.
- B. Install hangers and supports according to Section 200529.

3.4 INSTALLATION - BURIED PIPING SYSTEMS

- A. Verify connection to existing piping system size, location, and invert are as indicated on Drawings.
- B. Establish elevations of buried piping with not less than 3 ft of cover.
- C. Establish minimum separation of 6' from other services domestic water piping according to IPC 2018 code.
- D. Excavate pipe trench according to Section 312316.
- E. Install pipe to elevation as indicated on Drawings.
- F. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding 4 inches compacted depth; compact to 95 percent maximum density.
- G. Install pipe on prepared bedding.
- H. Route pipe in straight line.
- I. Pipe Cover and Backfilling:
 - 1. Backfill trench according to Section 312323.

2. Maintain optimum moisture content of fill material to attain required compaction density.
3. After hydrostatic test, evenly backfill entire trench width by hand placing backfill material and hand tamping in 6 inches compacted layers to 6 inches minimum cover over top of jacket. Compact to 95 percent maximum density.
4. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
5. Do not use wheeled or tracked vehicles for tamping.

3.5 INSTALLATION - ABOVE GROUND PIPING

- A. Establish invert elevations, slopes for drainage to 1/8 inch per foot minimum. Maintain gradients.
- B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Provide clearance at cleanout for snaking drainage system.
- C. Encase exterior cleanouts in concrete flush with grade.
- D. Install floor cleanouts at elevation to accommodate finished floor.
- E. Install non-conducting dielectric connections wherever jointing dissimilar metals.
- F. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- G. Install piping to maintain headroom. Group piping to conserve space.
- H. Group piping whenever practical at common elevations.
- I. Support cast iron drainage piping at every joint.
- J. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 210516.
- K. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 220700.
- L. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Section 083113.
- M. Install piping penetrating roofed areas to maintain integrity of roof assembly.
- N. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- O. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 099000.
- P. Install bell and spigot pipe with bell end upstream.
- Q. Sleeve pipes passing through partitions, walls and floors. Refer to Section 220529.
- R. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping. Refer to Section 078400].

3.6 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements 017000 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Test storm drainage piping system according to local authority having jurisdiction.

3.7 SCHEDULES

- A. Pipe Hanger Spacing:
 - 1. Pipe Material: Cast iron.
 - a. Maximum Hanger Spacing: 5 feet.
 - b. Hanger Rod Diameter: 5/8 inch.
 - 2. Pipe Material: Cast iron, with 10-foot length of pipe.
 - a. Maximum Hanger Spacing: 6 feet.
 - b. Hanger Rod Diameter: 1/2 inch.
 - 3. Pipe Material: Copper tube.
 - a. Size: 1-1/4 inches and smaller.
 - b. Maximum Hanger Spacing: 6 feet.
 - c. Hanger Rod Diameter: 1/2 inch.
 - 4. Pipe Material: Copper tube.
 - a. Size: 1-1/2 inches and larger.
 - b. Maximum Hanger Spacing: 10 feet.
 - c. Hanger Rod Diameter: 1/2 inch.

END OF SECTION 221400

SECTION 22 34 00

FUEL-FIRED DOMESTIC WATER HEATERS

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. Commercial gas-fired water heaters.
 - 2. Packaged water heating systems.
 - 3. Domestic hot water storage tanks.
- B. Related Sections:
 - 1. Section 033000 - Cast-in-Place Concrete: Execution requirements for concrete housekeeping pads specified by this Section.
 - 2. Section 220700 - Plumbing Insulation: Field applied insulation for domestic water heaters.
 - 3. Section: 221100 - Facility Water Distribution: Supply connections to domestic water heaters.
 - 4. Section 231123 - Facility Natural-Gas Piping: Execution requirements for gas piping connections specified by this Section.
 - 5. Section 235100 - Breechings, Chimneys, and Stacks: Execution requirements for breeching, chimney, and stack connections to water heaters specified in this Section.
 - 6. Section 260503 - Equipment Wiring Connections: Execution requirements for electric connections specified by this Section.

1.3 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI Z21.10.1 - Gas Water Heaters Vol. I Storage Water Heaters with Input Ratings of 75,000 Btu per Hour or Less.
 - 2. ANSI Z21.10.3 - Gas Water Heaters - Vol. III Storage, with Input Ratings Above 75,000 Btu per Hour, Circulating and Instantaneous Water Heaters.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. American Society of Mechanical Engineers:
 - 1. ASME PTC 25 - Pressure Relief Devices.
 - 2. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.
- D. National Fire Protection Association:
 - 1. NFPA 54 - National Fuel Gas Code.

- E. United States Department of Energy:
 - 1. DOE 10 CFR - Uniform Test Method for Measuring the Energy Consumption of Furnaces.

1.4 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate heat exchanger dimensions, size of taps, and performance data. Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, taps, and drains.
- C. Product Data:
 - 1. Water Heaters: Submit dimensioned drawings of water heaters indicating components and connections to other equipment and piping. Indicate pump type, capacity and power requirements. Submit electrical characteristics and connection locations.
 - 2. Pumps: Submit certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
- D. Manufacturer's Installation Instructions: Submit mounting and support requirements.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit replacement part numbers and availability.

1.6 QUALITY ASSURANCE

- A. Conform to ASME Section VIII for construction of water heaters. Provide boilers registered with National Board of Boiler and Pressure Vessel Inspectors.
- B. Water Heater Performance Requirements: Equipment efficiency not less than prescribed by ASHRAE 90.1 when tested according to ANSI Z21.10.3.
- C. Perform Work according to Pennsylvania, Horsham Township standard.
- D. Maintain one copy of each document on Site.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.
- B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

1.8 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing Work of this Section.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Products storage and handling requirements.
- B. Accept water heaters on Site in original labeled cartons. Inspect for damage.
- C. Protect tanks with temporary inlet and outlet caps. Maintain caps in place until installation.

1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.11 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish three-year manufacturer warranty for domestic water heaters packaged water heating systems.

1.12 EXTRA MATERIALS

- A. Section 017000 - Execution and Closeout Requirements: Spare parts and maintenance products.

PART 2 - PRODUCTS

2.1 COMMERCIAL GAS FIRED WATER HEATERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. AO Smith – BTH-199Mxi (Basis of Design).
 - 2. Bradford White
 - 3. Rheem
 - 4. Or equal as approved by the Professional
- B. Furnish materials according to Pennsylvania, Horsham Township standards.
- C. Type: Automatic, natural gas-fired, vertical storage.
- D. Capacity:
 - 1. Storage Capacity: 100 gal.
 - 2. Input: 199,000 Btuh.
 - 3. Minimum Recovery Rate: 235 gph with 100 degrees F temperature rise.

4. Maximum Working Pressure: 150 psig.
 5. Certification: [ANSI Z21.10.1] [ANSI Z21.10.3].
- E. Tank: Glass-lined coating] welded steel ASME labeled.
 - F. Accessories: Brass water connections and dip tube, drain valve, magnesium anode, and ASME rated temperature and pressure relief valve.
 - G. Controls: Automatic water thermostat with adjustable temperature range from 120 to 180 degrees F. Automatic reset high temperature limiting thermostat factory set at 195 degrees F, gas pressure regulator, multi-ribbon or tubular burner, 100 percent safety shut-off pilot and thermocouple, flue baffle and draft hood.
 - H. Controls: Automatic direct immersion thermostat with temperature range adjustable minimum 175 degrees F differential. Automatic reset high temperature limiting thermostat factory set at 195 degrees F. Gas pressure regulator, multi-ribbon or tubular burner. One-hundred percent safety shut-off pilot and thermocouple, intermittent electronic ignition monitoring pilot and main flame, trial for re-ignition for momentary loss of flame, shut down of pilot and main burner in 2-4 seconds after loss of flame, and automatic flue damper and power vent.
 - I. Provide with Concentric Vent Kit.
 - J. Provide with Condensate Neutralization Kit.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Maintain manufacturer's recommended clearances around and over water heaters.
- B. Install water heater on concrete housekeeping pad, minimum 4 inches high and 6 inches larger than water heater base on each side. Refer to Section 033000.
- C. Connect natural gas piping according to NFPA 54.
- D. Connect natural gas piping to water heater, full size of water heater gas train inlet. Arrange piping with clearances for burner removal and service.
- E. Connect domestic hot & cold water piping to supply and return water heater connections.
- F. Install the following piping accessories. Refer to Section 221100.
 1. On Supply:
 - a. Thermometer well and thermometer.
 - b. Strainer.
 - c. Pressure gage.
 - d. Shutoff valve.
 2. On Return:
 - a. Thermometer well and thermometer.
 - b. Pressure gage.

c. Shutoff valve.

G. Install the following piping accessories on natural gas piping connections. Refer to Section 231123.

1. Strainer.
2. Pressure gage.
3. Shutoff valve.
4. Pressure reducing valve.

H. Install discharge piping from relief valves and drain valves to nearest floor drain.

I. Install circulator and diaphragm expansion tank on water heater.

J. Install water heater trim and accessories furnished loose for field mounting.

K. Install electrical devices furnished loose for field mounting.

L. Install control wiring between water heater control panel and field mounted control devices.

M. Connect flue to water heater outlet, full size of outlet. Refer to Section 235100.

N. Install Work according to Pennsylvania, Horsham Township standards.

3.2 SCHEDULES

a. Per Plans

END OF SECTION 223400

SECTION 22 40 00

PLUMBING FIXTURES

PART 1 GENERAL

1.1 STIPULATIONS

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

1.2 SECTION INCLUDES

- A. Lavatory (F-1)
- B. Handicap Water Closet (F-2)
- C. Water Closet (F-3)
- D. Urinal (F-4)
- E. Handicap Shower (F-5)
- F. Shower (F-6)
- G. Mop Basin (F-7)
- H. Sink (F-8)
- I. Water Hammer Arrestor
- J. Floor Drain
- K. Wall Hydrant
- L. Mini Tempered Water Mixing System

1.3 RELATED SECTIONS

- A. Section 12 34 50 – Laboratory Casework
- B. Section 07 92 00 - Joint Sealers.
- C. Section 20 05 29 - Supports and Anchors.
- D. Section 22 05 03 - Plumbing Piping.

1.4 REFERENCES

- A. ANSI/ASME A112.6.1 - Supports for Off-the-Floor Plumbing Fixtures for Public Use.
- B. ASME A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.
- C. ANSI/ASME A112.19.1 - Enameled Cast Iron Plumbing Fixtures.
- D. ANSI/ASME A112.19.2 - Vitreous China Plumbing Fixtures.
- E. ANSI/ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
- F. ANSI/ASME A112.19.4 - Porcelain Enameled Formed Steel Plumbing Fixtures.

- G. ANSI/ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals (Dimensional Standards).
- H. ANSI Z358.1 - Emergency Eyewash and Shower Equipment.
- I. ANSI/ARI 1010 - Drinking-Fountains and self-contained, Mechanically-Refrigerated Drinking-Water Coolers.

1.5 SUBMITTALS

- A. Submit under provisions of Section 20 00 01.
- B. Product Data: Provide catalogue illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
- C. Manufacturer's Installation Instructions.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 20 00 01.
- B. Maintenance Data: Include fixture trim exploded view and replacement parts lists.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 20 00 01.
- B. Accept fixtures on site in factory packaging. Inspect for damage.
- C. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.8 FIELD MEASUREMENTS

- A. Verify that field measurements are as instructed by the manufacturer.

1.9 WARRANTY

- A. Provide one year warranty under provisions of Section 20 00 01.
- B. Warranty: Include coverage of electric water cooler compressor.

1.10 EXTRA MATERIALS

- A. Furnish under provisions of Section 20 00 01.
- B. Provide two sets of faucet washers and flush valve service kits.

PART 2 PRODUCTS

2.1 LAVATORY (F-1)

1. Lavatory Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Kohler K-8189 (Basis)
 - b. American Standard
 - c. Zurn
 - d. Or equal as approved by the Professional
2. Faucet Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Moen CA8302 (Basis)
 - b. Kohler
 - c. Delta
 - d. American Standard
 - e. Zurn
 - f. Or equal as approved by the Professional
3. Trap Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. McGuire 8872C (Basis)
 - b. Brasstech
 - c. Zurn
 - d. Or equal as approved by the Professional
4. Supplies Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. McGuire LFBV170 (Basis)
 - b. Brasstech
 - c. Zurn
 - d. Or equal as approved by the Professional

2.2 HANDICAP WATER CLOSET (F-2)

1. Water Closet Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. American Standard AFWall Millenium (Basis)
 - b. Kohler
 - c. Zurn
 - d. Or equal as approved by the Professional
2. Flush Valve Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Moen 8310 (Basis)
 - b. Kohler
 - c. American Standard
 - d. Zurn
 - e. Sloan
 - f. Or equal as approved by the Professional
3. Toilet Seat Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

- a. American Standard 5901.100 (Basis)
- b. Kohler
- c. Zurn
- d. Or equal as approved by the Professional
- 4. Carrier Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Zurn ZN1201-NL4 (Basis)
 - b. Josam
 - c. Jay R. Smith
 - d. Or equal as approved by the Professional

2.3 WATER CLOSET (F-3)

- 1. Water Closet Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. American Standard Aftwall Millenium (Basis)
 - b. Kohler
 - c. Zurn
 - d. Or equal as approved by the Professional
- 2. Flush Valve Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Moen 8310 (Basis)
 - b. Kohler
 - c. American Standard
 - d. Zurn
 - e. Sloan
 - f. Or equal as approved by the Professional
- 3. Toilet Seat Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. American Standard 5901.100 (Basis)
 - b. Kohler
 - c. Zurn
 - d. Or equal as approved by the Professional
- 4. Carrier Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Zurn ZN1201-NL4 (Basis)
 - b. Josam
 - c. Jay R. Smith
 - d. Or equal as approved by the Professional

2.4 URINAL (F-4)

- 1. Water Closet Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. American Standard Washbrook (Basis)
 - b. Kohler
 - c. Zurn
 - d. Or equal as approved by the Professional
- 2. Flush Valve Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

- a. Moen 8310 (Basis)
- b. Kohler
- c. American Standard
- d. Zurn
- e. Sloan
- f. Or equal as approved by the Professional
- 3. Carrier Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Zurn ZN1201-NL4 (Basis)
 - b. Josam
 - c. Jay R. Smith
 - d. Or equal as approved by the Professional

2.5 SHOWER (F-5 & F-6)

- 1. Shower Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Moen 82604 (Basis)
 - b. Kohler
 - c. America Standard
 - d. Delta
 - e. Or equal as approved by the Professional
- 2. Drain Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Zurn ZS880-48 (Basis)
 - b. Schluter
 - c. Delta
 - d. Or equal as approved by the Professional

2.6 MOP BASIN (F-7)

- 1. Mop Basin Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Fiat MSB2424 (Basis)
 - b. Zurn
 - c. American Standard
- 2. Faucet Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Fiat 830AA (Basis)
 - b. Zurn
 - c. American Standard
 - d. Or equal as approved by the Professional

2.7 SINK (F-8)

- 1. Sink Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Elkay DLR312210PD-3 (Basis)
 - b. Kohler
 - c. Kraus
 - d. Or equal as approved by the Professional
- 2. Faucet Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

- a. Moen 87303 (Basis)
- b. Kohler
- c. Delta
- d. American Standard
- e. Zurn
- f. Or equal as approved by the Professional
- 3. Trap Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. McGuire 8872C (Basis)
 - b. Brasstech
 - c. Zurn
 - d. Or equal as approved by the Professional
- 4. Supplies Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. McGuire LFBV170 (Basis)
 - b. Brasstech
 - c. Zurn
 - d. Or equal as approved by the Professional

2.8 Water Hammer Arrestor (WHA)

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Jay R. Smith 5200 Series (Basis)
 - b. Zurn
 - c. Sioux Chief
 - d. Watts
 - e. Oatey
 - f. Or equal as approved by the Professional
- 2. Absorber with wrought copper cold rolled and spun closed seamless shell, type I copper tube, hydro-pneumatic air cushion, poly piston with two epdm o-rings lubricated with dow-corning fda approved 111 silicone compound, seamless reduction, lead free solder joint, standard wrought copper adapter with wrench hex, wrought copper adapter and male threaded connections, installed with ball valve.
- 3. Certified to ANSI/ASSE 1010
- 4. Max. Working temp. = 250F
- 5. Max. Working press. = 350 PSIG
- 6. Burst tested to 2,900 PSIG

2.9 Exterior Wall Hydrant (Hose-Bibb)

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Jay R. Smith 5515 (Basis)
 - b. Watts
 - c. Zurn
 - d. Or equal as approved by the Professional

2.10 Interior Wall Hydrant (Hose-Bibb)

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Zurn Z1349-VB Series (Basis)

- b. Watts
- c. Jay R. Smith
- d. Or equal as approved by the Professional

2.11 Floor Drain (FD)

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Jay R. Smith 2515 (Basis)
 - b. Zurn
 - c. Josam
 - d. Sioux Chief
 - e. Or equal as approved by the Professional
2. 3" Deep trap seal
3. Hinged Grate
4. Cast Iron Construction
5. Certified to ANSI 112.21

2.12 Clean Out (CO)

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Jay R. Smith 4021S (Basis)
 - b. Zurn
 - c. Josam
 - d. Sioux Chief
 - e. Or equal as approved by the Professional
2. Flashing Flange with Clamp
3. Gasket seal – bronze plug
4. Hinged Grate
5. Cast Iron Construction

2.13 Mini Tempered Water Mixing System

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Lawler, Model 802 Mini (Basis)
 - b. Taco
 - c. Bradley
 - d. Or equal as approved by the Professional
2. ASTM grade materials, flow to shut off upon hot or cold water failure, tamper-resistant high temperature limit stop to prevent adjustment above 130°F, provide inlet check valves, Thermostat, lead free, 1" SWT inlet connections, 1-1/4" SWT outlet connection.
3. Accuracy: $\pm 3^{\circ}\text{F}$
4. Outlet temperature range (70°F – 140°F)
5. Maximum pressure: 125 psig
6. Maximum inlet temperature: 140°F
7. Minimum supply pressure 30 psi (207 kpa)
8. Rated Flow @ 10 PSI – 39 GPM
9. Rated Flow @ 45 PSI – 80 GPM
10. Grundfos Magna3 32-60 F N pump
11. RMS unit with remote digital temp. monitoring
12. ASSE 1017 Certified

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.
- B. Verify that electric power is available and of the correct characteristics.

3.2 PREPARATION

- A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install each fixture with trap, easily removable for servicing and cleaning.
- C. Provide chrome-plated rigid or flexible supplies to fixtures with loose key screwdriver stops, reducers, and escutcheons.
- D. Install components level and plumb.
- E. Install and secure fixtures in place with wall supports or wall carriers and bolts.
- F. Seal fixtures to wall and floor surfaces with sealant as specified in Section 07900, color to match fixture.

3.4 ADJUSTING

- A. Adjust work under provisions of Section 01700.
- B. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.5 CLEANING

- A. Clean work under provisions of 01700.
- B. At completion of construction, clean plumbing fixtures and equipment.

3.6 PROTECTION OF FINISHED WORK

- A. Protect finished Work under provisions of Section 01500.
- B. Do not permit use of fixtures.

END OF SECTION 224000

SECTION 23 05 00

GENERAL REQUIREMENTS MECHANICAL

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 APPLICATION

- A. The conditions of this Section apply to each and every Contract and Contractor or other person or persons supplying any material or labor involved in this project either directly or indirectly
- B. The Contractor shall be intimately involved with all new and existing equipment and their required service, maintenance, and removal access. In addition, the Contractor shall be coordinated with the owner to understand the owners requirements for access to and around all equipment and the owners required operations. The Contractor shall coordinate and conduct all operations and install all new piping, valves, accessories, equipment in manners to avoid hindering upon equipment and owners access and operations.
- C. No construction materials, debris, cleaning solutions, wash water or other forms of illicit discharges shall enter the storm sewer system. All sanitary sewer waste shall comply with the requirements of Biddle Airforce Base.

1.03 HANGERS AND PIPING SUPPORTS

- A. General
 - 1. Each Contractor shall provide all hangers and hanger supports required for his work under his contract.
 - 2. All support components shall conform to Manufacturers Standardization Society Specification MSS-SP-58, latest edition, Underwriters Laboratories, Inc., and Factory Mutual Division Standards.
 - 3. No chain, wire or perforated strap shall be used. Use continuous or partially threaded rods. Where rod is over eighteen inches (18") provide lateral bracing on alternate sides for every fourth hanger along pipe. Rods shall be coupled as required.
 - 4. Provide additional support for valves and specialties above three inches (3"), brace laterally.
 - 5. Contractor providing hangers and supports shall provide supplementary prime coated steel as required for their installation and field painting.
 - 6. Any damage to the insulation vapor barriers shall be repaired at the Contractor's expense.
 - 7. Provide Trymer insulation having a minimum compressive strength of 200 PSI at all hanger points. Cut insulation and pack between pipe and insert on protection shield. Minimum length of insulation shall be 18". Extend vapor barrier of adjacent insulation around insulation and insert.
- D. Installation - Vertical Piping
 - 1. Support piping at each floor with riser clamps as follows:
 - a. Steel pipe – steel support.

- b. Copper tubing – constructed of copper or steel copper plated support.
- 2. All vertical piping 1-1/4" and smaller located on walls shall be supported with split ring type pipe clamps secured midway between floor and ceiling. Split ring pipe clamps to be similar to type 12 extension split pipe clamp shown in MSS-SP-58. Provide to bolt type with extensions. Pipe clamp materials must be compatible with piping materials.

1.04 PIPING OVER ELECTRICAL EQUIPMENT

- A. Do not install any piping or fittings over the top of or within a distance of six feet (6') measured horizontally from all switchboards, panelboards, motors, metering assemblies, bus ducts and associated equipment. Where deviation from these requirements is necessary and piping passes over such equipment, provide a watertight galvanized sheet metal trough around and under piping to completely contain water leakage. Provide drain provisions in troughs and pipe to nearest floor drain. Owner approval is required prior to installing piping over electrical equipment.

1.05 UNIONS AND FLANGES

- A. Install accessible unions or flanges in supply and return connections and adjacent to all equipment, fixtures, specialties, automatic valves and at all other points in all systems where required to facilitate replacement and maintenance of specialties or equipment.
- B. Install mating flanges at flanged valves and at all equipment having flanged connections.
- C. All flanges shall be faced, spot faced and drilled to ASME standard.
- D. Unless otherwise specified or indicated, unions and flanges shall be rated as follows:
 - 1. Ferrous Pipe: Unions shall be 150 psig ground joint, malleable iron, threaded type, conforming to ASTM A-197.
 - 2. Flanges in welded black steel piping shall be forged steel welding neck, 150 lb. standard, conforming to ASTM A-181 and ANSI B16.5.
 - 3. Copper tubing 2" and smaller: Unions shall be wrought copper unions, ground joint, solder ends, conforming to ASA B16.22.
 - 4. Dielectric Connections:
 - a. Up thru 2 inch: Nipple type.
 - b. Above 2 inch: Flange with isolating gasket and bolt hole inserts. Use brass bolts on flanges. Flange material to match connecting pipe.
 - c. Plastic coated nipple-type dielectric connections are acceptable up through 2".
 - 5. Copper tubing 2 1/2" and larger; cast bronze flanges 150 lb. class, solder ends, conforming to ASA B16.34.
 - 6. All flanged connections shall include gasket recommended for the service intended.

1.06 NIPPLES

- A. All nipples shall be of the same material and pipe schedule as used for system. No close nipples or all thread nipples shall be used.

1.07 VALVES - GENERAL

- A. Provide all valves required for proper operation of systems whether indicated on drawing or not.
- B. All valves shall be fully packed ready for service.
- C. Valves shall be installed with stems or spindles above the horizontal where possible.
- D. All flanged valves shall be faced, spot faced and drilled American Standard or extra heavy as required.
- E. Provide valves at all automatic valves, check valves and all equipment for proper isolation for repairs while system is in operation as indicated on drawings.
- F. Ball valves with male hose end connectors complete with cap and chain in the bottom of all vessels and elsewhere shall be provided as required or indicated to permit complete venting and drainage of all systems.
- G. Use flanged valves when connecting to flanged equipment or specialties.

1.08 INSULATION - GENERAL

- A. Schuller as standard of design and construction. Owens-Corning or Knauf equivalents acceptable.
- B. Test, clean, dry and approve piping, fittings, valves, casings, housings, and all other items before application of insulation. Insulation shall include all insulating materials, their application and finishes as required and in accordance with the manufacturer's instructions.
- C. Thermal and acoustic insulating materials, including the pipe insulation, jackets, facings and adhesives used to adhere jacket or facing to the insulation, including fittings and butt strips, shall have a non-combustible fire and smoke hazard system rating and label as tested by ASTM E-84, NFPA 255 and UL 73, not exceeding flame spread 25, fuel contributed 50, smoke developed 50. Accessories such as adhesives, mastics, cements, tapes and caulk for fittings shall have the same ratings as listed above. All products and materials shall bear the UL label including the vapor barrier jacket of each section of insulation.
- D. All insulation shall be applied by experienced personnel in accordance with manufacturer's printed installation instructions.

1.09 ELECTROLYSIS CONTROL

- A. All copper to ferrous piping connections shall be made with the use of dielectric nipples or fittings.
- B. Connection between bronze valves and ferrous piping do not require electrolysis control.
- C. Refer to Nipples and Flanges herein.

1.10 PRESSURE VESSELS

- A. All vessels subjected to pressure shall conform to the ASME Code, Commonwealth of Pennsylvania requirements, and shall be constructed, inspected and stamped accordingly.

1.11 COORDINATION DRAWINGS

- A. Refer to Section 01 40 00 – Quality Requirements.
- B. Each Sub-Contractor shall be responsible for participating in all coordination meetings and preparing coordination drawings in conjunction with all Sub-Contractors. The coordination process will be led by the CM. The Mechanical Contractor shall be responsible for the base drawing including major building components and all mechanical scope. Each Sub-Contractor shall be responsible for adding their scope of work to the drawings created by the Mechanical Contractor. Each Sub-Contractor shall also be responsible for identifying, detailing, and coordinating around the existing utilities and building components.
- C. Contractors and all sub-contractors shall prepare plans depicting the location of all materials to be furnished and/or installed under the Contract using AutoCAD 2018 or later.
- D. Drawing scale shall be minimum of $3/8" = 1'-0"$.
- E. Where the work of several trades and/or contracts occurs in one space, provide plans drawn at a minimum scale of $1/2" = 1'-0"$ and elevations and sections drawn at a minimum scale of $3/8" = 1'-0"$.
- F. Dimension all piping and equipment, including Owner furnished equipment, from building column lines. Indicate elevation of all piping.
- G. Coordination drawings shall be prepared in full for one (1) submission and review. Sketches and manufacturers' catalog cuts will not be accepted.
- H. Submit drawings to all sub-subcontractors for inclusion of their work on the drawings. The controls subcontractor shall include all control conduits to field devices and locate all necessary junction boxes and A.T.C. panels
- I. Upon completion of the coordination drawings by one contractor for the work under this Contract, submit such to Subcontractors and other Prime Contractors on the Project for incorporation of general, electrical power, lighting, sprinkler and plumbing materials and equipment.
- J. Coordinate with all Prime Contractors and Subcontractors as required to develop a complete set of coordination drawings.
- K. Coordination drawings shall not be used as piping hanger and support, or vibration isolation, sprinkler, sheetmetal, or large bore piping shop drawings that require separate, independent submittals after the approval of the coordination drawings.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 230500

SECTION 23 05 14

VARIABLE FREQUENCY DRIVES

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 other Division 1 Specification Sections, apply to this Section.

1.3 WORK INCLUDED

- A. Furnish and install variable frequency drives (VFD's or drives) for mechanical equipment as scheduled on the drawings and specified herein. The term VFD shall refer to the entire assembly including, but not limited to, the drive by-pass and any accessories included to achieve the objectives of this specification. Private Label products shall not be used without prior approval of the Owner.
- B. The VFD's shall comply with the latest applicable standards of ANSI, IEEE, NEMA, NEC, UL and /or field tested and certified by an approved testing agency such as ABM, ETL or Met Labs to UL standards under a field testing program. The controllers shall be rated as indicated. As a minimum, the full load output current of the drive shall be equal to the equivalent motor horsepower as listed by NEC Table 430-150.
- C. Drive horsepower shall be minimum size as indicated. Coordinate size with driven equipment manufacturer. Submit a VFD schedule which includes motor synchronous rpm, brake horse power (BHP) required, voltage and rated frequency, VFD technology, EMI/RFI, input impedance, dimensions, NEMA/UL enclosure type/rating, ambient temperature rating, short circuit withstand rating and serial communications capabilities (imbedded or add-on card; communications protocol) for coordination and approval by Owner or Owner's Representative.
- D. Provide all accessories as integral components to the drive assembly unless noted otherwise on the drive schedule. Entire assembly shall be UL listed and meet NEC. Bypass panels shall be constructed of UL recognized components, assembled in a UL listed enclosure in strict accordance with the NEC for electrical safety. The assembly shall be UL listed.

1.4 SCOPE

- A. This section is applicable for all VFD's supplied to Owner or Owner's Representative, either as separate items to be mounted in the field or shipped to an OEM for factory mounting in packaged systems.

1.5 RELATED SECTIONS

- A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.6 REFERENCES

- A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.
- B. Material standards shall be as specified or detailed in the following:
 - 1. IEEE: Institute of Electrical and Electronic Engineers
 - a. IEEE 519-1992, Guide to Harmonic Content and Control.
 - 2. NEMA: National Electrical Manufacturers Association
 - a. ICS 7.0, AC Adjustable Speed Drives
 - 3. MG 1-78: Motors and Generators
 - 4. NEC: National Electrical Code
 - a. NEC 430.120, Adjustable Speed Drive Systems
 - 5. ANSI: American National Standards Institute
 - 6. UL: Underwriter's Laboratories
 - 7. IBC International Building Code
 - a. IBC 2012 Seismic – referencing ASC 7-05 and ICC AC-156
 - 8. IEC International Electrotechnical Commission
 - a. EN/IEC 61800-3
 - 9. Underwriters Laboratories (as appropriate) (UL)
 - a. eUL508
 - b. UL508A
 - c. UL508C

1.7 SUBMITTALS

- A. See Section 23 05 00 and General Conditions for additional requirements.
- B. Product Data: Provide product description and list of materials, including the following:
 - 1. Harmonic calculations

- a. From Owner or Owner's Representative supplied list of all existing drives on the system.
 - b. From Owner or Owner's Representative supplied, simplified one line diagram of existing conditions indicating linear loads as well as non-linear loads such as VFD's; transformers and the Point of Common Coupling (PCC).
 - c. Technical description of the program, name of the program and version used for the calculations.
 - d. Description of all inputs and outputs from the program.
- 2. Complete drawings shall be furnished and approved before proceeding with manufacture. Drawings shall consist of a specific bill of materials, connection diagrams and suitable outline drawings showing details necessary to locate conduit stub-ups and field wiring.
 - a. Details including all labeling.
 - b. Assembled panel short circuit rating and how it will be labeled.
 - c. Heat release of the drive.
- 3. Description of field testing by a certified test agency after installation.
 - a. Proposed schedule of testing shall be submitted to Owner or Owner's Representative.
- 4. Manufacturer's Instructions: Contractor shall indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.8 QUALITY ASSURANCE

- A. Manufacturers must have more than twenty (20) years of documented experience in the design, testing and manufacturing of specified products.
- B. Provide Compliance Document that the products provided meet or exceed the specification requirements.

1.9 WARRANTY

- A. Attention is directed to provisions of the General Conditions and Supplementary General Conditions regarding guarantees and warranties for work under this Contract.
- B. Manufacturers shall provide guarantees for products and their functionality under this Contract. However, such guarantees shall be in addition to and not in lieu of all other liabilities which the manufacturer and the Contractor may have by Law or by other provisions of the Contract Documents.
- C. All materials, items of equipment and workmanship furnished under each Section shall carry a warranty against all defects in material and workmanship. Any fault due to defective or improper material, equipment, workmanship or design which may develop shall be made good, forthwith, by and at the expense of the Contractor including all other damage done to areas, materials and other systems resulting from this failure.
- D. Upon receipt of notice from the Owner or Owner's Representative of failure of any part of the systems or equipment during the warranty period, the affected part or parts shall be replaced by the Contractor, within three (3) working days, at no cost to the Owner or Owner's Representative.

- E. The Contractor shall furnish a written guarantee covering the above requirements before the final payment is made.
- F. VFD manufacturer's warranty shall include drive replacement or parts; all labor and travel expenses for a minimum of five (5) years from date of shipment.
- G. VFD manufacturer shall be ISO 9001 certified.
- H. VFD manufacturer shall provide a toll-free phone number for service & warranty support
- I. The Contractor shall guarantee that all components of the systems provided under his Contract, are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated.

PART 2 – PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES

A. General

1. Provide a complete variable frequency drive (VFD) (in a single enclosure) of capacity, quantity and characteristics as described in this specification and as shown and scheduled on the drawings. Supplied VFD systems shall meet IEEE 519-1992 at the PCC.
2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1) Allen Bradley (Basis of Design) (Powerflex 400 Series)
 - 2) ABB (Model ACH550 w/ E-Cclipse Bypass)
 - 3) Square D (E Flex, M flex)
 - 4) Yaskawa (Z1000)
 - 5) Or equal as approved by the Professional
3. All VFDs shall be of the same manufacturer.
4. Each drive and assembly shall be U.L. listed and labeled.
 - a. Label shall include the AIC rating for the assembly which shall not be less than 100,000 AIC or higher as required by short circuit study UNO. Unless specifically noted in the schedule, any unit shipped without such label shall be removed from the job with NO EXCEPTIONS. This also includes six pulse drives with or without bypasses.
5. Installation and start-up services for the equipment shall be covered by this specification.
6. Winning bidder must meet with Owner's HVAC contractor no less than three (3) weeks prior to work in each phase to coordinate controls interface, tracing of wires and confirmation of replication of existing interfaces if the VFD is used in an HVAC system.
7. Input/output control signals shall be compatible with automatic controls and/or building automation control system in use in the building where the drive is installed. Submit written, signed off coordination with submittal. Communication protocols supported may include BACnet MS/TP,, BACnet/IP, Johnson Controls N2, Siemens Building Technology FLN (P1), Modbus RTU and/or LonWorks or as shown on drawings.

8. Complete drawings shall be furnished and approved before proceeding with manufacture. Drawings shall consist of a specific bill of materials, connection diagrams and suitable outline drawings showing details necessary to locate conduit stub-ups and field wiring.
9. The VFD manufacturer shall supply with submittal information, harmonic calculations made in accordance with IEEE 519-1992 Standards showing the specified THVD, line notching and the specified THCD limits are met as indicated on the VFD schedule or project drawings. Calculations shall assume worst case system conditions. System 1-line, transformer data, standby generator data, and primary fault current data required to make these calculations are provided in the system short circuit study and can be obtained from the Owner or Owner's Representative, if available. If the short circuit study is not available, the harmonic analysis shall be re-calculated upon the Owner receiving the system short circuit study. The submittal shall include, as a minimum, the following information:
 - a. All input data and assumptions.
 - b. Explanation of method used to perform the analysis.
 - c. All calculations and computer printouts used in the analysis, including input documentation.
 - 1) List all drives and accessories.
 - 2) Explanation of all inputs
 - 3) Explanation of all outputs.
 - d. A system impedance diagram based on the Electrical one-line diagrams. It shall be the drive manufactures responsibility to obtain all information required.
 - e. All calculations shall be in accordance with IEEE 519 with all drives at 100% speed.
 - f. All calculations shall be with maximum load on the transformer no greater than 70% of its nominal capacity for single ended substations or 35% for double-ended substations or as shown on the drawings/project documents. Normal operations is with the tie breaker open. Submit calculations with tie breaker both open and closed.
 - g. The VFD schedule shall assign the VFD's into the following categories: "Special Applications", "General System" or "Dedicated System" categories. The distortion limits shall be assigned according to these categories. If no designation is made, Special Applications category will be used.
 - h. Special Applications category applies to VFD's installed in patient care or medical lab buildings. The THD (voltage) will be less than 3%
 - i. General System category applies to non-patient or non-lab buildings. The THD (voltage) will be less than 5%.
 - j. Dedicated System category applies to locations where a substation is dedicated exclusively to the system being controlled, such as the North Energy Plant – chillers area. The THD (voltage) will be less than 10%.

- k. Current distortion limits are as shown in the Harmonic Table below, based on the short circuit to load current ratio. Use transformer with 50% motor contribution combined short circuit current available, based on unlimited primary short circuit kVA. Owner to provide transformer voltage, size (kVA) and impedance (%Z):

ISC / IL	Harmonic Order (Odd Harmonics)					THD
	H<11	11<h17	17<h23	23<h35	35<h	
<20	4.0	2.0	1.5	0.6	0.3	5.0
20-50	7.0	3.5	2.5	1.0	0.5	8.0
50-100	10.0	4.5	4.0	1.5	0.7	12.0
100-1000	12.0	5.5	5.0	2.0	1.0	15.0
>1000	15.0	7.0	6.0	2.5	1.4	20.0

- l. Provide a Field Measurement Harmonics Test report with a detailed description of the tests, procedures and supporting calculations required to substantiate the installed systems compliance with the specified THD voltage limits.
- 1) The description shall include information on the proposed test equipment and test conditions.
 - 2) Include the name and qualifications of the firm which will conduct the field tests.
- m. Submittals without calculations will not be reviewed.
- n. VFD software shall be included in drive package.
10. Drives shall be capable of the full rated motor current at all carrier frequencies of that drive.

B. Construction

1. VFD

- a. VFDs shall be a minimum of 6-pulse input. Provide data and calculations showing the drive harmonics.
- b. 5% impedance line reactors shall be provided on each drive as a minimum.
- c. The use of the following devices are permitted:
 - 1) Active harmonic filters at each drive or if drives are fed from a common panel, the filter can be placed at a common panel equal to TCI model HGA and integrated into the system. Refer to Elec. Plans.

2. All Drives

- a. The VFD shall be of the pulse width modulated (PWM) design converting the fixed utility voltage and frequency to a variable voltage and frequency output. VFDs utilizing a 3rd power section are not acceptable. Efficiency shall exceed 96% at 100% speed and load. Line side displacement power factor shall exceed (0.95) regardless of speed and load. The VFD shall be rated for 110% current for one (1) minute for variable torque loads and 150% current for one (1) minute for constant torque loads.
- b. VFD's located indoors shall be housed in a single NEMA/UL Type 12 metal enclosure (including 18-pulse transformer, filters, line reactor, and other required accessories) unless noted on the drawings otherwise, such as in the North or South energy plants where individual components will be used. If air intakes in the

enclosure can allow dust to get into the electronics, the intakes shall be filtered. The contractor shall be responsible to maintain a clean, cool, dry operating environment if the VFD must be run during construction.

- c. Drives located outside shall be provided with a single NEMA/UL Type 3R stainless steel enclosure and an independent heating and ventilating system to maintain manufacturer's ambient operating conditions.
- d. The VFD shall not produce excessive nor objectionable motor acoustical noise. Carrier frequency shall be adjustable to mitigate objectionable acoustical noise. All VFD's shall include EMF/RFI filters. The VFD shall comply with standard EN 61800-3 for the First Environment, restricted level with up to 100' of motor cables. Certified test lab reports shall be provided with the submittal.
- e. Drives located other than outside (submit list of all drives individually indicating):
 - 1) Space where drive is located.
 - 2) Space ventilation is adequate, space air conditioning is adequate or the size of the cooling provided in the drive.
 - 3) Space heating is adequate or the size of the heater provided in the drive.
- f. Standard operating conditions shall be:
 - 1) Incoming 3-phase 480 VAC power or as indicted on the drawings, +5% or -10%, 60 Hz.
 - 2) Humidity 0 to 95% (non-condensing and non-corrosive).
 - 3) Altitude 0' to 3,300' above sea level.
 - 4) Ambient temperature 0° to 45°C (113°F).
- g. Provide devices such as TCI model DV/DVT filters or equal to protect motors from reflected wave damage commonly caused by long motor-to-VFD distances. VFD manufacturer to review cable lengths and provide filter as required. Shop Drawings shall indicate max distance allowable without filters for each VFD size.
- h. VFDs shall include the following system interfaces:
 - 1) 1) The following I/O signals (AI = analog input, AO = analog output, DI = Digital Input (dry contact closure), DO = Digital Output (dry contact closure)) shall be able to control the drive when hardwired to the drive to match specific job requirements as designed. These include, but not limited to:
 - a) AI: Speed setpoint
 - b) AO: Drive speed output in %, engineering units or Hertz (programmable)
 - c) AO: Drive output current in in %, engineering units or Amps (programmable)
 - d) DI: Start command, momentary contact or maintained contact (user selectable)
 - e) DI: Stop command, momentary contact
 - f) DI: Drive reset from error condition
 - g) DI: Drive or Bypass mode – trip drive or bypass for all motors
 - h) DI: H-O-A maintained contact
 - i) DO: Drive running
 - j) DO: Drive error/trip

- k) DO: Drive in auto mode
 - l) DO: Drive in bypass mode - off
 - m) DO: Drive in Bypass mode – running
 - n) DO: Drive bypass - error/motor tripped (single or multiple motors, as applicable)
- 2) Speed reference interface with a differential amplifier or isolated input 0-10 VDC or 4-20 mA DC signals.
- 3) 3-15 PSI Follower for speed reference if indicated on drawings. Coordinate with controls contractor to provide as indicated.
- 4) VFD Run relay with an isolated set of Form C contacts.
- 5) Bypass Run relay with an isolated set of Form C contacts.
- 6) Minimum of 2 programmable contacts.
- 7) Trip contacts (Form C).
- 8) VFD will accept an external trip contact and indicate so on the display.
- 9) Dedicated terminal blocks for interface with maintained remote start contacts.
- 10) Output signal proportional to output frequency (0-10 VDC or 4-20 mA DC).
- 11) Output signal proportional to output current (0-10 VDC or 4-20 mA DC).
- 12) Provided with communications capability to provide complete interface with the ATC control and automation system. These include Ethernet, BACnet, Modbus Plus, Johnson or Honeywell protocols, Profibus and LonWorks. Built-in capabilities are preferred. Communications capability shall be listed on the drawings or other project documentation, if required.
- 13) If BACnet is utilized for the application, manufacturer shall provide the PICS.
- 14) If Modbus is utilized for the application, manufacturer shall provide the Modbus map.
- i. The VFD shall include the following protective features:
 - 1) Lockable Fused disconnect (or breaker) rated for 100,000 AIC or higher as required by system short circuit study.
 - 2) Electronic instantaneous overcurrent protection.
 - 3) DC bus undervoltage protection.
 - 4) DC bus overvoltage protection.
 - 5) Output ground fault protection.
 - 6) Ability to withstand output line-to-line short circuits without component failure.
 - 7) Status indication via a solid state display of the following protective functions in English:
 - a) DC Bus Undervoltage
 - b) Overcurrent
 - c) DC Bus Overvoltage
 - d) Controller Overtemperature
 - e) Overload

- f) A single light to indicate a VFD trip/alarm is needed.
- 8) Overload capability shall be 110% of the inverter rating for (1) minute.
- 9) Selectable auto restart.
- 10) VFD will catch a motor spinning in the forward or reverse direction upon starting (flying start).
- 11) Upon loss of the input signal (4-20 mA), the drive will stop or go to a preset speed, user selectable.
- j. Standard adjustments shall include:
 - 1) Minimum frequency (0-60 Hz)
 - 2) Maximum frequency (40-320 Hz)
 - 3) Minimum of three (3) preset speeds (4-120 Hz) initiated by contact closures
 - 4) Minimum of three (3) acceleration times (2-600 seconds)
 - 5) Minimum of three (3) deceleration times (2-600 seconds)
 - 6) Minimum speed dwell time (0-18 seconds)
 - 7) Voltage boost (0-40V) for starting torque control
 - 8) Current limit (70-120%)
 - 9) Critical frequency avoidance ([3] bands with 30 Hz adjustable widths)
- k. Door mounted operator, removable keypad and status indication using a multi-line, backlit LCD display shall include the following attributes:
 - 1) Common operator interface for all drives w/in this project.
 - 2) Means to upload and download drive parameters to aid start-up of multiple drives.
 - 3) Hand/Off/Auto selection and indication (keypad or remote)
 - 4) Speed control selection and indication
 - 5) Forward/Reverse selection and lockout
 - 6) Manual speed adjustment
 - 7) Frequency meter
 - 8) Motor speed (RPM, % or engineering units)
 - 9) Ammeter
 - 10) Output voltage
 - 11) Output current
 - 12) Drive temperature
 - 13) Drive DC bus voltage
 - 14) Elapsed time meter
 - 15) English display (not alpha-numeric trouble codes)
 - 16) Lockable keypad (password protection)
 - 17) Fault reset
 - 18) Help button which brings up "on-line" assistance for programming and troubleshooting.

- 19) Built-in time clock with battery back-up and 10 year minimum life span.
 - 20) Fault and operating parameters log with date/time stamp at time of fault.
 - 21) Drive trip cause
 - 22) Time clock has ability to start/stop drive, set drive speed, PID parameter sets and output relays.
 - 23) All applicable operating parameters shall be displayed in engineering units.
 - 24) A minimum of three (3) operating values shall be able to be displayed at all times.
- I. The reverse button and the programming functions may be locked-out, if desired.
- 3. Interior heaters shall be provided to maintain the minimum drive temperature when the drive is off for NEMA 3R applications.
 - 4. A Customer Interlock Terminal Strip, allowing for a minimum of 4 independent safety inputs – provide a separate terminal strip for connection of fire, smoke, freeze contacts and external start command. All external interlocks and start/stop contacts shall function with drive in hand, auto or bypass.
 - a. Damper control circuit shall be operable in the hand, auto and bypass.
 - b. Operator Interface (OI) shall display text selectable by user for each safety interlock using plain English such as Firestat, Freezestat, Over/Under Pressure.
 - c. For a single or redundant VFD dedicated to each motor application, the safety switch located at the motor shall have an interlock switch input that shall shut down the VFD(s) using a dedicated interlock input point. The OI shall indicate specifically that the external interlock switch is off.
 - d. For single or redundant VFD operating multiple motors, as in a fan array or other multi-motor application, each motor shall have a dedicated interlock switch input that shall trip the respective motor circuit protector (MCP)'s shunt trip. This interlock switch input shall disconnect the power to the respective motor, but allow VFD to continue operation for the remainder of the motors connected to the VFD. Power from the MCP can only be restored upon manual reset of the MCP. The OI shall indicate specifically that an external interlock switch is off.
 - 5. Service
 - a. The VFD manufacturer shall provide a start-up service package for all VFDs provided. Service shall include inspector for final adjustment, operational checks, and a final report for record purposes. The service package shall include a (5) year parts and labor from date of delivery and be performed by factory trained service engineers. The service center must be permanently located within (100) miles of the job site and able to provide 24-hour service.
 - 6. Protection
 - a. The VFD shall be protected against damage at all times. The drive shall be stored in a clean, dry environment with temperature and humidity within the range as specified by the drive manufacturer. Space heaters shall be energized controlled storage as recommended by the manufacturer. Storage space shall be environmentally controlled and maintained.
 - b. Contractor shall provide appropriate media/apparatus to filter cooling air for the drive intakes if the drive is to run during construction.
 - 7. Factory Tests and Checks
 - a. VFD power semiconductors and diodes shall be 100% inspected and tested, including load testing.

- b. Small signal semiconductors, resistors, capacitors and diodes shall be lot sampled. Testing shall include parameter, as well as functional characteristics.
 - c. All printed circuit boards shall be tested under a temperature cycling (0°C to +65°C) 24-hour load test and then functionally tested via fault finder bench equipment prior to unit installation.
 - d. All final assemblies shall be tested at full load with application of line-to-line and line-to-ground bolted faults. The VFD shall trip electronically without device failure.
8. For drives less than 50 HP, provide a (1) day training course for Owner's personnel and shall be presented by representatives of the manufacturer at the jobsite. Provide an option for two days of on-site training per set of separate series drives.

PART 3 – EXECUTION

3.1 VFD INSTALLATION

- A. Install in accordance with manufacturer recommendations, Contract Drawings, and reviewed submittals.
- B. Confirm motors connected to the drive are suitable/compatible for use with the drive installed.
- C. Install to meet the Local and State Electrical Code and so as to ensure easy accessibility for service, removal, or replacement of all components.
- D. Provide supplemental steel, support, rods and hangers necessary to hang or mount VFDs.
- E. Receive and inspect VFDs to ensure they are without defect. Defective or damaged VFDs shall be returned to the manufacturer.
- F. Protect equipment to prevent damage from water, dust, dirt, or accident. Protection shall include, but not be limited to changing filters when dirty or providing temporary plastic wrap to maintain equipment in original factory condition.
- G. Wiring installation and handling shall be in accordance with manufacturer's recommendations.
- H. Coordinate VFD programming with driven equipment for any resonant frequencies or RPM limits such that these conditions are avoided when the drive system is installed and before turning over to the Owner or Owner's Representative.
- I. Provide field testing (as described in Paragraph 3.2 of this Section).
- J. Provide final cleaning of interior or exterior of VFD.

3.2 FIELD TESTS AND CHECKS

- A. Testing, checkout and start-up of the VFD equipment shall be performed under the technical direction of the manufacturer's service engineer. Under no circumstances are any portions of the drive system to be energized without authorization from the manufacturer's representative.
- B. The Contractor shall provide independent harmonic testing by an independent testing company. Provide readings with printouts of the harmonic current at each harmonic as well as the total voltage distortion. The following readings shall be provided:
 - 1. At each point of common coupling:

- a. With all drives running with load
 - b. With all drives off
2. At the power connection to each drive:
 - a. With the drive running loaded
 - b. With drive off
3. All the above data shall be submitted to the Owner or Owner's Representative for review. If these tests shown that the drives are not in compliance with the Specifications, the drive manufacturer shall make all changes required to comply with the Specifications at no cost to the Owner or Owner's Representative. If required, this could mean replacing the drives that are not in compliance.
4. A copy of all tests and checks performed in the field, complete with meter readings and recordings, where applicable, shall be submitted to the Owner or Owner's Representative for this record.

END OF SECTION 230514

SECTION 23 05 23

HVAC VALVES AND STRAINERS

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 other Divisions Specification Sections, apply to this Section.

1.3 WORK INCLUDED

- A. Furnish and install all shut-off, globe, check, strainers, balancing and other type valves as shown and as required to make a complete and operational system.
- B. Provide isolation valves at all drains, piping mains and branches at all piping systems, equipment, risers and before and after all control valves.
- C. Secure all permits and local/state approval for the installation of all components included under this Section.

1.4 RELATED SECTIONS

- A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.5 REFERENCES

- A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.
- B. Material standards shall be as specified or detailed hereinafter and as follows:
 - 1. MSS SP-11- Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; Manufacturers Standardization Society of the Valve and Fittings Industry.
 - 2. MSS SP-55 – Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components, Manufacturers Standardization Society of the Valve and Fittings Industry.
 - 3. MSS SP-67 – Butterfly Valves Manufacturers Standardization Society of the Valve and Fittings Industry.

4. MSS SP-69 – Pipe Hangers and Supports – Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry.
5. MSS SP –70 - Cast Iron Gate Valves, Flanged and Threaded Ends; Manufacturers Standardization Society of the Valve and Fittings Industry.
6. MSS SP-71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends; Manufacturers Standardization Society of the Valve and Fittings Industry.
7. MSS SP-78 - Cast Iron Plug Valves, Flanged and Threaded Ends; Manufacturers Standardization Society of the Valve and Fittings Industry.
8. MSS SP-80 – Bronze Gate, Globe, Angle and check Valves; Manufacturers Standardization Society of the Valve and Fittings Industry.
9. MSS SP-82 – Valves Pressure Testing Methods, Manufacturers Standardization Society of the Valve and Fittings Industry.
10. MSS SP-84 – Steel Valves Socket and Threaded Ends, Manufacturers Standardization Society of the Valve and Fittings Industry.
11. MSS SP-85 – Cast Iron Globe & Angles Valves, Flanged and Threaded Ends; Manufacturers Standardization Society of the Valve and Fittings Industry.
12. MSS SP-89 – Pipe Hangers and Supports – Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry.
13. NFPA30 – Flammable and Combustible Liquid Code.
14. NFPA54 – National Fuel Gas Code; National Fire Protection Association.
15. UL 1479 – Standard for Fire Tests of Through-Penetration Firestops; Underwriters Laboratories Inc.

1.6 SUBMITTALS

- A. See Section 230500 and General Conditions for additional requirements.
- B. Product Data: Include data on valve materials, pressure class, construction, dimensions and ratings. Provide manufacturers catalogue information. All valves of one type shall be by one specific manufacturer. Provide data for joining and materials required, i.e., dope, tape, cement, primer, flux, solder, rods, etc.
- C. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable designation.
- D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- E. Project Record Documents: Record actual locations of all valves and valve tag numbers.
- F. Maintenance Data: Include spare parts list and exploded valve assembly views.

1.7 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing valve and strainer products specified in this section, with documented experience.
- B. Installer: Company specializing in performing work of the type specified in this section, with documented experience.

- C. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
- D. All valves and strainers shall contain manufacturer's name and pressure class marked on the valve body.

1.8 REGULATORY REQUIREMENTS

- A. Perform Work in accordance with all State and Local codes.
- B. Conform to all State and Local code for installation of safety valves and backflow prevention devices.
- C. Provide certificate of compliance from the authority having jurisdiction indicating approval of installation of all boilers, pressure vessels, gas piping, vents and backflow prevention devices.

1.9 DELIVERY, STORAGE AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Valves and strainers shall be kept clean and protected from damage.

PART 2 – PRODUCTS

2.1 GENERAL

- A. One valve manufacturer's figure numbers are listed; valves from other manufacturers listed in the list of acceptable manufacturers will be accepted.
- B. Provide all shutoff, gate, globe, check, strainers, balancing and other types of valves as shown on the drawings and required for proper operation, maintenance, isolation and safety of all piping systems.
- C. Provide isolation valves at all drains and piping mains and branches for all water, steam and condensate piping, at all equipment connections and before and after automatic control valves.
- D. All gate and globe valves 2-1/2" and above shall have a bolted gland follower.
- E. The pressure-temperature rating of valves shall be in accordance with Paragraph 2.3.
- F. Face-to-face and end-to-end dimensions of iron body valve shall conform to ANSI B16.10. Design workmanship, materials and testing shall conform to MSS-SP-70 (gates), MSS-SP-71 (swing checks) and MSS-SP-85 (globe).
- G. Face-to-face and end-to-end dimensions of steel body valves shall conform to ANSI B16.34.
- H. End-to-end dimensions of grooved ductile iron body valves shall conform to the latest published dimensions.
- I. Each valve body and seat shall be tested by the manufacturer and shall carry a permanently affixed indication that test have been successfully completed, with copy of the test data

furnished. All steel valves shall be tested in accordance with ANSI B16.34 standards at 1.5 times design pressure (hydrostatic test).

- J. All valves and/or strainers of the same type shall be of the same manufacturer. Before purchasing any valve, the Contractor shall submit for approval the name of the manufacturer, the figure number which he proposes to furnish and engineering data on each figure number. For acceptable manufacturers, see schedules herein.
 - K. Valves/Strainers in grooved piping systems may be grooved.
 - L. All valves used for balancing purposes, shall have memory stops.
 - M. Provide handwheels for all manually operated gate and globe valves and for all valves equipped with gear operators. Handwheels shall accept bolt-on chain operators.
 - N. Provide chain operators for all valves located 7'-0" above floor or higher.
 - O. Size valve handwheels for not more than 80 lbs. pull on one side of the handwheel to effect tight closure. Where the manufacturer's standard handwheel size is not large enough to accomplish this, provide a gear operator.
 - P. Valve bonnets and gear operators shall be designed to withstand all forces which may be applied to the handwheels, including those from chain operators.
 - Q. Valves and strainers shall be rated in accordance with the "Spec. Class No." Specified for that system.
- 2.2 Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
- A. High Performance Butterfly Valves
 - 1. Bray (Basis of Design)
 - 2. Keystone
 - 3. Nibco
 - 4. WKM
 - 5. Or equal as approved by the Professional
 - B. Venturi Manual Balancing Valves
 - 1. Armstrong (Basis of Design)
 - 2. Bell & Gossett
 - 3. Flow Design, Inc.
 - 4. Griswold
 - 5. Macon
 - 6. Nibco
 - 7. Or equal as approved by the Professional
 - C. Venturi Flow Meter Device
 - 1. Bell & Gossett (Basis of Design)
 - 2. Flow Design Inc.

3. Hispan
 4. Or equal as approved by the Professional
- D. Y-pattern, Multi-Turn Globe Balancing Valves
1. Armstrong (Basis of Design)
 2. Macon Balancing
 3. Tour & Anderson/TA Hydronics
 4. Or equal as approved by the Professional
- E. Check Valves
1. Swing
 - a. Nibco (Basis of Design)
 - b. Powell
 - c. Victaulic (Grooved Application Only)
 - d. Walworth
 - e. Watts
 - f. Or equal as approved by the Professional
 2. Silent
 - a. Keckley (Basis of Design)
 - b. Mueller Steam Specialty
 - c. Titan
 - d. Victaulic (Grooved Application Only)
 - e. Or equal as approved by the Professional
- F. Vacuum Breakers
1. Armstrong (Basis of Design)
 2. Sarco
 3. Watts
 4. Or equal as approved by the Professional
- G. Ball Valves
1. American (Basis of Design)
 2. Apollo
 3. Milwaukee
 4. Nibco
 5. Watts
 6. Or equal as approved by the Professional
- H. Strainers
1. Y Type
 - a. Armstrong (Basis of Design)
 - b. Keckley

- c. Mueller Steam Specialty
 - d. Sarco
 - e. Titan
 - f. Victaulic (Grooved Application Only)
 - g. Or equal as approved by the Professional
- 2. Basket
 - a. Eaton (Basis of Design)
 - b. Elliot (Tate Andale)
 - c. Mueller Steam Specialty
 - d. Or equal as approved by the Professional
- 3. Duplex
 - a. Water
 - 1) Elliott (Basis of Design)
 - 2) Kraissc
 - 3) Zurn
 - 4) Or equal as approved by the Professional

2.3 VALVE CHART

Service	Valve Type and Pressure Class ²		Material (Body/Trim)		Joints ¹
Size	2" & Smaller	2.5" & Larger	2" & Smaller	2.5" & Larger	2.5" & Larger
Heating Water Supply and Return	Ball Class 600	Butterfly Class 150 High Performance	Bronze / Stainless Steel	Cast Steel / Stainless Steel	Flanged or Grooved
Makeup and Fill					
Miscellaneous Drains					

1 Joints 2" and less shall be threaded connections with the exception of refrigerant piping and components which shall be Silver Brazed.

2 Valve Class is as specified in ANSI and MSS Standards.

3 Ball valves in steam systems are only suitable for drains and vents 2" and smaller. Ball valves must be rated 250 WSP with a full port, cast steel body and stainless steel ball and stem.

2.4 BALL VALVE

A. Up to 2" (for water below 200°F)

1. Threaded Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Apollo product #77-14X (Basis of Design)
 - b. Milwaukee
 - c. Watts
 - d. Or equal as approved by the Professional
2. Drains and Vent Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Apollo 10-14X-HC (Basis of Design)
 - b. Milwaukee
 - c. Watts
 - d. Or equal as approved by the Professional
3. Full port
4. All stainless steel ball and stem
5. Extended stem for insulation
6. Two piece bronze body
7. 600 PSIG WOG
8. 125 PSIG

B. 2 1/2" and Up

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. American product #4000D (Basis of Design)
 - b. Apollo
 - c. Watts
 - d. Or equal as approved by the Professional
2. Flanged
3. Stainless steel ball and stem
4. Ductile iron body epoxy coated

2.5 SWING CHECK VALVES

- A. Access to Elements
 1. Up to 2" except as noted: Screw-in caps
 2. 2-1/2" and Up: Bolted or coupled covers

2.6 SILENT CHECK VALVES

- A. Spring Loaded, Globe
 1. Iron body, bronze trim for valves up to 125 psi.
 2. Body Flanged Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Mueller product #105MAT (Basis of Design).
 - b. Armstrong
 - c. Nibco
 - d. Or equal as approved by the Professional
 3. Body Grooved Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Victaulic Series 716 (Sizes to 12") (Basis of Design)
 - b. Victaulic Series W715 (Sizes 14" to 24") (Basis of Design)
 - c. Armstrong
 - d. Nibco
 - e. Or equal as approved by the Professional
- B. Spring Loaded, Conical Brass Disc
 1. Bronze body, stainless steel trim, for valves up to 400 psi WOG non-shock.
 2. PTFE seat.
 3. Body threaded Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Watts Series LF 600 (Basis of Design)
 - b. Armstrong

- c. Nibco
- d. Or equal as approved by the Professional

2.7 VENTURI MANUAL BALANCING VALVES (2" & SMALLER)

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Armstrong model CBV-VT (Basis of Design)
 - 2. Macon model MB
 - 3. Griswold model QS
 - 4. Flow Design Inc. mode. UA-SBS
 - 5. Bell & Gossett model MV
 - 6. Or equal as approved by the Professional
- B. Provide a venturi flow meter manual balancing valve with locking memory stop. Ball valve models shall have a stainless steel ball & stem.

2.8 BUTTERFLY VALVES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Bray Model 41 (Basis of Design)
 - 2. Keystone
 - 3. WKM
 - 4. Or equal as approved by the Professional
- B. Sizes 2 1/2" and larger shall be an ANSI class valve equal to or greater than the class specified for the service but in no case be less than ANSI Class 150.
- C. Body shall be ASTM A216, Type WCB carbon steel with a fully lugged body suitable for bi-directional tight shut off to full rated pressure without a downstream flange.
- D. Valve shall have no disk contact with the seat when in the open position. Seal suitable for the operating service and operating temperature plus 50°F.
- E. Bearings shall be constructed of SS/Graphite.
- F. Seats shall be PTFE, Zero leakage.
- G. Valve shall be of the double off-set design.
- H. The disk shall be 316 stainless steel.
- I. The shaft shall be 17-4 PH stainless steel.
- J. The disk pin shall be 316 or 17-4 stainless steel.
- K. Seat retainer ring fasteners shall not be in contact with system fluid.
- L. The disk shall be stainless steel.
- M. Operator
 - 1. Lever Operator for Valve Sizes less than 6" except steam service shall be Infinite Positioner: Ductile iron ASTM A536. Provide operator with position indicator which shall also indicate "open" and "closed" position. Provide memory stop.
 - 2. Gear Operator for Valve Sizes 6" and Greater as well as all sizes for steam service shall be Cast Iron ASTM A126 Class B housing. Bronze shaft bearings. Steel ASTM A216 worm gear. Ductile iron ASTM A536 segment gear. Ductile iron ASTM Aa536

handwheel. Minimum handwheel diameter shall be 12" for valve sizes through 20", and 18" for valves larger than 20". Provide operator with position indicator and shall also indicate "open" and "closed" position. Provide memory stop. All gearing shall be enclosed in a housing.

2.9 GENERAL STRAINERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Muller 11M (≤ 2 "), Muller 781 (> 2 ") (Basis of Design)
 - 2. Watts
 - 3. Titan
 - 4. Or equal as approved by the Professional
- B. Body
 - 1. 150 lbs. WSP Class, cast steel up to 100 psi. Note cast brass may be used for copper piping systems.
 - 2. 250 lbs. WSP Class, cast steel for 100 to 250 psi.
 - 3. 300 lbs. WSP Class, forged steel or cast steel over 250 psi.
- C. Screen
 - 1. 316 Stainless steel or Monel.
 - 2. Free area not less than 2.5 times inlet area.
 - 3. Perforations (unless noted otherwise)
 - a. Water
 - 1) Up to 4": 1/16"
 - 2) 6" & 8": 1/8"
 - 3) 10" & Up: 5/32"
 - 4. Construction
 - a. Screen wire gauge to suit size and service.
 - b. Reinforced.

2.10 Y-TYPE STRAINERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Mueller 251 (Screwed), 758G (Grooved), 781 (Flanged) (Basis of Design)
 - 2. Victaulic
 - 3. Titan
 - 4. Or equal as approved by the Professional
- B. Screwed
 - 1. Faced cap, straight thread and gasket.
- C. Grooved

1. Coupled cover.
- D. Flanged
 1. Bolted cover.
 2. Class 150 psi steel.

2.11 BASKET TYPE STRAINERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 1. Mueller 185 (Basis of Design)
 2. Watts
 3. Titan
 4. Or equal as approved by the Professional
- B. Bolted cover, bottom drain connection.

PART 3 – INSTALLATION OF VALVES AND STRAINERS

3.1 VALVES

- A. Provide valves, check valves, balancing cocks as noted and as indicated on drawings. Provide as specified and install in strict compliance with the manufacturer's recommendations.
- B. Shutoff Valves
 1. Inlets and outlets of equipment.
 2. All branch connections to mains.
 3. As noted.
- C. Check Valves
 1. Pump Discharges: Silent check valves
 2. Other Locations: Types as noted
- D. Valves
 1. Accessible, but no valve handles pointing down below horizontal position. Removable without separating or lifting piping in which valves are installed. Provide cap screws on threaded bodies. Where abutting flanged strainers or similar devices, position valve with respect to device so as to permit removal of bolts.
- E. Drain valves at low points in water piping and where noted. Valve installation shall be so handle is fully operational. Do not shorten or alter handle.
 1. In Equipment Rooms
 - a. Up to 3" Pipe: 3/4" ball valve
 - b. 4" to 8" Pipe: 1 1/2" ball valve
 - c. 10" & Up Pipe: 2 1/2" ball valve
 2. 1/2" drain valve with capped hose connection except in equipment rooms.

- F. Manual air vents at high points and where required to expel air.
 - 1. Up to 3" Pipe
 - a. Line size air chamber, 12" long, 1/2" ball valve.
 - 2. 4" to 8" Pipe
 - a. Line size air chamber, 6" long, 1/2" ball valve.
 - 3. 10" & Up
 - a. Line size pipe cap, 1/2" ball valve.
- G. Where possible install gate, globe and ball valves with stems upright and not more than 15° off of vertical, not inverted.
- H. Where possible install butterfly valves with stems in horizontal position and with the low point of disc opening with the direction of flow.
- I. Provide stem extensions on all valves such that hand wheel or lever extends beyond insulation and is operable.
- J. Gate valves shall not be utilized for chilled water, condenser water, and hot water services. Use ball valves (line sizes through 2-1/2") and butterfly valves (line sizes 3" & larger) for chilled, condenser, and hot water services.
- K. All butterfly valves in water services shall be of the high performance type.
- L. Venturi manual balancing valves, venturi flow meter devices and Y-pattern, multi-turn globe balancing valves shall be installed in accordance with the manufacturer's recommendations or instructions.
- M. Provide spring loaded silent type check valves on discharge of pumps.
- N. Install swing check valves in horizontal position only.
- O. Provide drain valves at low points between valves, low points of piping system and at equipment.
- P. All steam service high performance butterfly valves shall be provided with gear operators.
- Q. Threaded valves shall be provided with a union within 6" on downstream side of valve.
- R. Grooved end valves shall be provided with grooved joint couplings.
- S. Butterfly valves shall not be used for balancing.
- T. Butterfly valves shall be installed between weld neck flanges or with grooved joint couplings of the same manufacturer only.
- U. Provide chain operated sheaves for valves in exposed areas located more than 7'-0" from floor. Provide chain lever kits for all ball valves in exposed areas located more than 7'-0" from floor. Extend chains to 5'-0" from above floor and hook to clips arranged to clear walking aisles.
- V. Flat faced flanges shall match flat faced flanges on equipment & valves. Flat faced flanges shall use full faced 500F Teflon gaskets.

3.2 VENTURI MANUAL BALANCING VALVES (3/4" & SMALLER)

- A. Individual Terminal Units & Coils: Install a venturi flow meter manual balancing valve with locking memory stop on the return branch for individual heating & cooling coils, VAV terminal reheat coils, unit heaters, cabinet unit heaters & finned tube radiation elements. Coil connection kit balancing valves with "so called" unions consisting of small copper flanges with O-ring gaskets are unacceptable.

3.3 VENTURI MANUAL BALANCING VALVES (1" through 2")

- A. Individual Terminal Units & Coils: Install a venturi flow meter manual balancing valve with locking memory stop on the return branch for individual heating & cooling coils, VAV terminal reheat coils, unit heaters, cabinet unit heaters & finned tube radiation elements.
- B. For a Group of Terminal Units: Install a venturi flow meter manual balancing valve with locking memory stop on the return branch for a group of 4 or more terminal reheat coils, unit heaters or finned tube radiation elements.
- C. Branch Piping to a Floor: Install a venturi flow meter manual balancing valve with locking memory stop in the return piping main on floor branch piping at the piping riser.
- D. Bank of Heating or Cooling Coils: Install a venturi flow meter manual balancing valve with locking memory stop on the return main from a bank of heating or cooling coils.

3.4 VENTURI FLOW METER DEVICE (2-1/2" through 4")

- A. Individual Terminal Units & Coils: Install a venturi flow meter device with differential readout ports with a throttling ball valve with locking memory stop on the return branch for individual heating & cooling coils, VAV terminal reheat coils, unit heaters, cabinet unit heaters & finned tube radiation elements.
- B. For a Group of Terminal Units: Install a venturi flow meter device with differential readout ports and a throttling ball valve with a locking memory stop on the downstream side of the venturi flow meter on the return branch for a group of 4 or more terminal reheat coils, unit heaters or finned tube radiation elements.
- C. Branch Piping to a Floor: Install a venturi flow meter device with differential readout ports and a throttling ball valve with a locking memory stop on the downstream side of the venturi flow meter in the return piping main on floor branch piping at the piping riser.
- D. Bank of Heating or Cooling Coils: Install a venturi flow meter device with differential readout ports and a throttling ball valve with a locking memory stop on the downstream side of the venturi flow meter on the return main from a bank of heating or cooling coils.

3.5 Y-PATTERN OR STRAIGHT PATTERN, MULTI-TURN GLOBE BALANCING VALVE (6" and larger)

- A. A Group of Terminal Units: Install a Y-pattern or straight pattern, multi-turn globe balancing valve paired with an isolation butterfly valve downstream on the return branch for a group of 4 or more terminal reheat coils, unit heaters or finned tube radiation elements.
- B. Branch Piping to a Floor: Install a Y-pattern or straight pattern, multi-turn globe balancing valve paired with an isolation butterfly valve downstream in the return piping main on floor branch piping at the piping riser.

- C. Bank of Heating or Cooling Coils: Install a Y-pattern or straight pattern, multi-turn globe balancing valve paired with an isolation butterfly valve downstream on the return main from a bank of heating or cooling coils.

3.6 STRAINERS

- A. Valved and provided with hose connection chain and cap. (See strainer assembly detail.)
- B. Line size, except as noted.
- C. Locate upstream of:
 - 1. Pumps
 - 2. Automatic control valves 2" and larger
 - 3. Pressure reducing valves
 - 4. Other equipment as noted
 - 5. As indicated

END OF SECTION 230523

SECTION 23 05 48

VIBRATION ISOLATION

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 SECTION INCLUDES

- A. Vibration isolation.

1.03 RELATED SECTIONS

- A. General Conditions of the Construction Services Agreement.
- B. Division 01 - All Sections.
- C. Section 20 05 00 - General Requirements.
- D. Section 20 05 10 - Definitions.
- E. Section 20 05 31 - Supports and Anchors
- F. Section 21 05 00 - Common Work Results for Fire Suppression
- G. Section 23 21 13 – Hydronic Piping
- H. Section 23 21 23 - Hydronic Pumps
- I. Section 23 34 00 - HVAC Fans

1.04 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Shop Drawings: Indicate and locate vibration isolators and spring hangers, with static and dynamic load on each, including hanger rod size and type. Shop drawing shall be prepared and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania.
- C. Product Data: Provide schedule of vibration isolator type with location and load on each, catalog data, and load capacity
- D. Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.
- E. Design Data: Indicate load carrying capacity of C-Channel supports, multiple pipes, and load of piping and accessories for each hanger.
- F. Manufacturer's Certificate: Certify that isolators are properly installed and adjusted to meet or exceed specified requirements.

1.05 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01.
- B. Record actual locations of hangers including attachment points.

PART 2 PRODUCTS

2.01 VIBRATION ISOLATION PADS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Mason Industries (Basis of Design)
 - 2. Vibro-Acoustics
 - 3. Regupol Vibration
 - 4. CDM
 - 5. Getzner
 - 6. Or equal as approved by the Professional
- B. RTUs & ERVs mounted on Roof Curbs
 - 1. Isolation pads shall create a system with an approximate natural frequency of 10 Hz
 - 2. Pads shall be located under all equipment rails, for the full length of all support.

2.02 VIBRATION ISOLATORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Mason Industries (Basis of Design)
 - 2. Vibro-Acoustics
 - 3. Amber-Booth
 - 4. Carpenter and Patterson
 - 5. Anvil
 - 6. Or equal as approved by the Professional
- A. Open Spring Isolators - Fans.
 - 1. Spring Isolators:
 - a. For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 - 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection 1" minimum deflection.
 - 3. Spring Mounts: Provide with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
 - 4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
- B. Steel Housed Restrained Spring Isolators: Pipe stanchions; SLR Series as required.
 - 1. Spring Isolators:
 - a. For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.

2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection of 1" minimum deflection.
 3. Spring Mounts: Provide with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
 4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
 5. Restraint: Provide heavy mounting frame and limit stops.
 6. Removable Spring Assembly.
 7. Housing: Welded steel enclosure with top plate, rigid lower housing, and blocking device.
- C. Spring Hangers: Type 30N
1. Spring Isolators: Piping systems:
 - a. For Exterior, Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection of 1" minimum with retainers.
 3. Housings: Rectangular steel box capable of 200% minimum overload without visible deformation. Incorporate elastomer hanger with threaded insert.
 4. Misalignment: Capable of 20 degree hanger rod misalignment.
 5. Load transfer plate to hold piping at fixed elevation during installation and permit transferring load to spring after installation.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install spring hangers without binding.
- C. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
- D. Connect wiring to isolated equipment with flexible hanging loop.
- E. Install on rooftop equipment curbs.

3.02 MANUFACTURER'S FIELD SERVICES

- A. Examine systems under provisions of Division 01.
- B. Provide field supervision to assure correct installation and alignment.
- C. Inspect isolated equipment after installation and submit report. Include static deflections.

END OF SECTION 230548

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

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. Testing, adjusting, and balancing of air systems.
 - 2. Testing, adjusting, and balancing of hydronic, and steam systems.
 - 3. Measurement of final operating condition of HVAC systems.
 - 4. Sound measurement of equipment operating conditions.
 - 5. Vibration measurement of equipment operating conditions.
 - 6. Written documentation and reports of above testing, adjusting, balancing, and measurements.
- B. Related Sections:
 - 1. Section 23 08 00 – Commissioning of HVAC
 - 2. Section 23 09 23 - Direct-Digital Control System for HVAC: Requirements for coordination between DDC system and testing, adjusting, and balancing work.
 - 3. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation for HVAC equipment.

1.3 REFERENCES

- A. Associated Air Balance Council:
 - 1. AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.
- C. Natural Environmental Balancing Bureau:
 - 1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Prior to commencing Work, submit proof of latest calibration date of each instrument and proof AABC or NEBB technician certification for all field balancing technicians who will be performing the work and completing reports.
- C. Test Reports: Indicate data on AABC MN-1 National Standards for Total System Balance forms or NEBB Report forms.

- D. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- E. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms, and copy of AABC National Project Performance Guaranty or copy of NEBB Certificate of Conformance Certification
- F. Submit draft copies of report for review prior to final acceptance of Project.
- G. Furnish Four (4) original reports in 3-ring binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with balancing report data sheets, and indicating thermostat locations.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of flow measuring stations, dampers, and balancing valves including rough and final settings.
- C. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with AABC MN-1 National Standards for Field Measurement and Instrumentation, Total System Balance or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
- B. Maintain one copy of each document on site.
- C. Prior to commencing Work, calibrate each instrument to be used. Upon completing Work, recalibrate each instrument to assure reliability. Submit calibration certificates.

1.7 QUALIFICATIONS

- A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum five (5) years documented experience certified by AABC or NEBB.
- B. Agencies: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. National Balancing Company.
 - 2. Fisher Balancing Company.
 - 3. WM. J. Donovan
 - 4. Butler Balancing Company
 - 5. Or equal as approved by the Professional
- C. Perform Work under supervision of AABC Certified Test and Balance Engineer or NEBB Certified Testing, Balancing and Adjusting Supervisor.

1.8 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

- B. Convene minimum one week prior to commencing work of this section.

1.9 SEQUENCING

- A. Section 01 10 00 - Summary: Work sequence.
- B. Sequence balancing between completion of systems tested and Date of Substantial Completion.

1.10 SCHEDULING

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify systems are complete and operable before commencing work. Verify the following:
 - 1. Systems are started and operating in safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.
 - 9. Access doors are closed and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage is minimized.
 - 12. Hydronic systems are flushed, filled, and vented.
 - 13. Pumps are rotating correctly.
 - 14. Proper strainer baskets are clean and in place or in normal position.
 - 15. Service and balancing valves are open.

3.2 PREPARATION

- A. Furnish instruments required for testing, adjusting, and balancing operations.
- B. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.3 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design.
- B. Air Outlets and Inlets: Adjust total to within plus and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

- C. Hydronic Systems: Adjust to within plus or minus 5 percent of design.

3.4 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Verify recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.
- E. Report defects and deficiencies noted during performance of services, preventing system balance.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner.
- H. Check and adjust systems approximately six months after final acceptance and submit report.

3.5 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities.
- B. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.
- E. Use volume control at terminal devices to regulate air quantities only to extent needed to offset small differences in air volume (less than 5%) and to the extent that such adjustments do not create objectionable noise.. Effect volume control by using volume dampers located in ducts.
- F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed and to obtain full modulation range of VFD controlled fans. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

- K. At modulating damper locations, take measurements and balance at extreme conditions. Balance variable volume systems at maximum airflow rate, full cooling, and at minimum airflow rate, full heating.
- L. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches positive static pressure.

3.6 WATER SYSTEM PROCEDURE

- A. Adjust water systems, after air balancing, to obtain design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow-metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in system adjusted for actual load conditions in accordance with manufacturers' performance data.
- C. Adjust systems to obtain specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open or in normal position to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Where available pump capacity is less than total flow requirements or individual system parts, simulate full flow in one part by temporary restriction of flow to other parts and proportionally balance the common distribution systems.

3.7 SCHEDULES

- A. Equipment Requiring Testing, Adjusting, and Balancing:
 - 1. HVAC Pumps.
 - 2. Air Handling Units (AHUs).
 - 3. Heat Recovery Systems
 - 4. Reheat and Cooling Air Coils.
 - 5. Terminal Heat Transfer Units.
 - 6. Fans.
 - 7. Air Filters
 - 8. Air Terminal Units.
 - 9. Air Inlets and Outlets.
 - 10. Boilers
- B. Report Forms
 - 1. Title Page:
 - a. Name of Testing, Adjusting, and Balancing Agency
 - b. Address of Testing, Adjusting, and Balancing Agency
 - c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
 - d. Project name
 - e. Project location
 - f. Project Architect
 - g. Project Engineer
 - h. Project Contractor

- i. Project altitude
 - j. Report date
2. Summary Comments:
- a. Design versus final performance
 - b. Notable characteristics of system
 - c. Description of systems operation sequence
 - d. Summary of outdoor and exhaust flows to indicate building pressurization
 - e. Nomenclature used throughout report
 - f. Test conditions
3. Instrument List:
- a. Instrument
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Range
 - f. Calibration date
4. Electric Motors:
- a. Manufacturer
 - b. Model/Frame
 - c. HP/BHP and kW
 - d. Phase, voltage, amperage; nameplate, actual, no load
 - e. RPM
 - f. Service factor
 - g. Starter size, rating, heater elements
 - h. Sheave Make/Size/Bore
 - i. On VFD controlled fans, operating frequency at final balance under peak airflow.
5. V-Belt Drive:
- a. Identification/location
 - b. Required driven RPM
 - c. Driven sheave, diameter and RPM
 - d. Belt, size and quantity
 - e. Motor sheave diameter and RPM
 - f. Center to center distance, maximum, minimum, and actual
6. Pump Data:
- a. Identification/number
 - b. Manufacturer
 - c. Size/model
 - d. Impeller
 - e. Service
 - f. Design flow rate, pressure drop, BHP and kW
 - g. Actual flow rate, pressure drop, BHP and kW
 - h. Discharge pressure
 - i. Suction pressure
 - j. Total operating head pressure
 - k. Shut off, discharge and suction pressures
 - l. Shut off, total head pressure
 - m. On VFD controlled pumps, operating frequency at final balance under peak water flow
7. Boiler Data:
- a. Identification/number
 - b. Manufacturer

- c. Size/model
 - d. Service
 - e. Design flow rate & pressure drop
 - f. Actual flow rate & pressure drop
 - g. Discharge Temperature
 - h. Return Temperature
 - i. Boiler firing rate.
 - j. Over-fire draft.
 - k. Gas flow rate.
 - l. Heat input.
 - m. Burner manifold gas pressure.
 - n. Percent carbon monoxide.
 - o. Percent oxygen.
 - p. Percent excess air.
 - q. Flue-gas temperature at outlet.
 - r. Ambient temperature.
 - s. Net stack temperature.
 - t. Percent stack loss.
 - u. Percent efficiency.
 - v. Heat output.
8. Reheat Coil Data:
- a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Water flow, design and actual
 - g. Water pressure drop, design and actual
 - h. Entering water temperature, design and actual
 - i. Leaving water temperature, design and actual
 - j. Entering air temperature, design and actual
 - k. Leaving air temperature, design and actual
 - l. Air pressure drop, design and actual

9. Energy Recovery Equipment:
 - a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Arrangement/Class/Discharge
 - f. Fresh Air flow, specified and actual
 - g. Return air flow, specified and actual
 - h. Outside air flow, specified and actual
 - i. Exhaust airflow specified and actual
 - j. Total supply static pressure (total external), specified and actual
 - k. Total exhaust static pressure (total external), specified and actual
 - l. Inlet pressure for each fan
 - m. Discharge pressure for each fan
 - n. Sheave Make/Size/Bore for each fan
 - o. Number of Belts/Make/Size for each fan
 - p. Fan RPM for each fan
10. Air Moving Equipment:
 - a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Arrangement/Class/Discharge
 - f. Air flow, specified and actual
 - g. Return air flow, specified and actual
 - h. Outside air flow, specified and actual
 - i. Total static pressure (total external), specified and actual
 - j. Inlet pressure
 - k. Discharge pressure
 - l. Sheave Make/Size/Bore
 - m. Number of Belts/Make/Size
 - n. Fan RPM
11. Return Air/Outside Air Data:
 - a. Identification/location
 - b. Design air flow
 - c. Actual air flow
 - d. Design return air flow
 - e. Actual return air flow
 - f. Design outside air flow
 - g. Actual outside air flow
 - h. Return air temperature
 - i. Outside air temperature
 - j. Required mixed air temperature
 - k. Actual mixed air temperature
 - l. Design outside/return air ratio
 - m. Actual outside/return air ratio
12. Exhaust Fan Data:
 - a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Air flow, specified and actual
 - f. Total static pressure (total external), specified and actual

- g. Inlet pressure
 - h. Discharge pressure
 - i. Sheave Make/Size/Bore
 - j. Number of Belts/Make/Size
 - k. Fan RPM
13. Duct Traverse:
- a. System zone/branch
 - b. Duct size
 - c. Area
 - d. Design velocity
 - e. Design air flow
 - f. Test velocity
 - g. Test air flow
 - h. Duct static pressure
 - i. Air temperature
 - j. Air correction factor
14. Duct Leak Test:
- a. Description of ductwork under test
 - b. Duct design operating pressure
 - c. Duct design test static pressure
 - d. Duct capacity, air flow
 - e. Maximum allowable leakage duct capacity times leak factor
 - f. Test apparatus
 - 1) Blower
 - 2) Orifice, tube size
 - 3) Orifice size
 - 4) Calibrated
 - g. Test static pressure
 - h. Test orifice differential pressure
 - i. Leakage
15. Terminal Unit Data:
- a. Manufacturer
 - b. Type, constant, variable, single, dual duct
 - c. Identification/number
 - d. Location
 - e. Model number
 - f. Size
 - g. Minimum static pressure
 - h. Minimum design air flow
 - i. Maximum design air flow
 - j. Maximum actual air flow
 - k. Inlet static pressure
16. Air Distribution Test Sheet:
- a. Air terminal number
 - b. Room number/location
 - c. Terminal type
 - d. Terminal size
 - e. Area factor
 - f. Design velocity
 - g. Design air flow
 - h. Test (final) velocity
 - i. Test (final) air flow

- j. Percent of design air flow
- 17. Sound Level Report (All rotating equipment):
 - a. Location
 - b. Octave bands - equipment off
 - c. Octave bands - equipment on
 - d. RC level - equipment on
- 18. Vibration Test (All rotating equipment):
 - a. Location of points:
 - 1) Fan/pump bearing, drive end
 - 2) Fan/pump bearing, opposite end
 - 3) Motor bearing, center (when applicable)
 - 4) Motor bearing, drive end
 - 5) Motor bearing, opposite end
 - 6) Casing/housing (bottom or top)
 - 7) Casing/housing (side)
 - 8) Duct/pipe after flexible connection or downstream of isolation devices (discharge)
 - 9) Duct/pipe after flexible connection or upstream of isolation devices (suction)
 - b. Test readings:
 - 1) Horizontal, velocity and displacement
 - 2) Vertical, velocity and displacement
 - 3) Axial, velocity and displacement
 - c. Normally acceptable readings, velocity and acceleration
 - d. Unusual conditions at time of test
 - e. Vibration source (when non-complying)

END OF SECTION 230593

SECTION 23 07 03

PIPING INSULATION

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 SECTION INCLUDES

- A. Piping insulation.
- B. Jackets and accessories.
- C. Insulation accessories.
- D. Preformed Thermal Jackets

1.03 RELATED SECTIONS

- A. General Conditions of the Construction Service Agreement.
- B. Division 01 - All Sections.
- C. Section 20 05 90 - Plant Mechanical Paints and Coatings
- D. Section 20 05 00 - General Requirements.
- E. Section 20 05 10 - Definitions.
- F. Section 20 05 31 – Supports and Anchors.
- G. Section 20 05 53 - Identification.
- H. Section 22 11 00 - Plumbing Piping.
- I. Section 22 11 19 - Plumbing Specialties
- J. Section 23 21 13 - Hydronic Piping.
- K. Section 23 26 16 - Hydronic Specialties

1.04 REFERENCES

- A. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
- B. ASTM C177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot- Plate Apparatus.
- C. ASTM C195 - Mineral Fiber Thermal Insulation Cement.

- D. ASTM C335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.
- E. ASTM C449 - Mineral Fiber Hydraulic-setting Thermal Insulating and Finishing Cement.
- F. ASTM C518 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- G. ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.
- H. ASTM C534 - Performed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- I. ASTM C547 - Mineral Fiber Performed Pipe Insulation.
- J. ASTM C552 – Standard Specification for Cellular Glass Thermal Insulation.
- K. ASTM C553 – Standard Specification for Mineral Fiber Blanket Thermal.
- L. ASTM C585 - Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
- M. ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.
- N. ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.
- O. ASTM D1667 - Flexible Cellular Materials - Vinyl Chloride Polymers and Copolymers (Closed Cell Foam).
- P. ASTM E84 - Surface Burning Characteristics of Building Materials.
- Q. ASTM E96 - Water Vapor Transmission of Materials.
- R. NFPA 255 - Surface Burning Characteristics of Building Materials.
- S. UL 723 - Surface Burning Characteristics of Building Materials.

1.05 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Product Data: Provide product description, list of materials and thickness for each service, and locations.
- C. Samples: Submit one sample illustrating each insulation type including mastic coatings and adhesives.
- D. Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.06 QUALITY ASSURANCE

- A. Materials: Flame spread/smoke developed rating of 25/50 or less in accordance with NFPA 255.

1.07 QUALIFICATIONS

- A. Applicator: Company specializing in performing the work of this section with minimum three years experience.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products to site under provisions of Section 01 60 00.
- B. Deliver materials to site in original factory packaging, labeled with manufacturer's identification including product density and thickness.
- C. Store insulation in original wrapping and protect from weather and construction traffic.
- D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.09 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

1.10 WARRANTY

- A. Division 01 – Execution Requirements: Product warranties and product bonds.
- B. Furnish five (5) year manufacturer warranty for man-made fiber.

PART 2 PRODUCTS

2.1 GLASS FIBER

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Schuller - Micro-Lok (Basis of Design)
 - 2. Knauf.
 - 3. Owens-Corning.
 - 4. Or equal as approved by the Professional
- B. Insulation: ASTM C547; rigid molded, noncombustible.
 - 1. "K" Value: ASTM C335, 0.24 at 75°F.
 - 2. Minimum Service Temperature: -20°F.
 - 3. Maximum Service Temperature: 850°F.
 - 4. Maximum Moisture Absorption: 0.2 percent by volume.
 - 5. Density: 4 pounds per cubic foot.
- C. Insulation: ASTM C165; Flexible Board Type Insulation
 - A. "K" Value ASTM C335, 0.27 at 75°F.
 - B. Minimum Service Temperature – 20°F.
 - C. Maximum Service Temperature – 650°F.

- D. Maximum Moisture Absorption – 0.2 percent by volume.
- E. Density: Three (3) pounds per cubic feet.
- D. Factory Applied Vapor Barrier Jacket:
 - 1. ASTM C921, White Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, suitable for field painting.
 - 2. Moisture Vapor Transmission: ASTM E96; 0.02 perm inches.
 - 3. Secure with self-sealing longitudinal laps and butt strips.
- E. Vapor Barrier Lap Adhesive:
 - 1. Foster Spark-FAS 85-20 adhesive.
 - 2. Compatible with insulation.
- F. Vapor Barrier/Lagging Adhesive:
 - 1. Foster Monolar 60 Series Mastic with custom color selection.
 - 2. ASTM C195; hydraulic setting on mineral wool.
- G. Field Applied Jacket Fabric:
 - 1. Foster Mast-A-Fab Membrane.
 - 2. Cloth: NFPA 90A and 90B, minimum 9 oz./sq.yd.

2.2 CELLULAR FOAM

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Armstrong AP Armaflex Shield (Basis of Design)
 - 2. Aeroflex USA
 - 3. K-Flex
 - 4. Or equal as approved by the Professional
- B. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.
 - 1. 'K' ('ksi') Value: ASTM C177 or C518; 0.27 at 75°F.
 - 2. Minimum Service Temperature: -40°F.
 - 3. Maximum Service Temperature: 220°F.
 - 4. Maximum Moisture Absorption: ASTM D1056; 5.0 percent (pipe) weight.
 - 5. Moisture Vapor Transmission: ASTM E96; 0.20 perm inches.
 - 6. Maximum Flame Spread: ASTM E84; 25.
 - 7. Maximum Smoke Developed: ASTM E84; 50.
 - 8. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive.
 - 1. Manufacturer: Armstrong 520 Adhesive.
 - 2. Air dried, contact adhesive, compatible with insulation.

2.3 INSERTS AND SHIELDS

- A. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.

- B. Insert Location: Between support shield and piping and under the finished jacket.
- C. Insert Configuration: Minimum 12 inches long, of same thickness and contour as adjoining insulation.
- D. Insert Material: Molded calcium silicate block: 100 PSI compressive strength, ASTM E84.

2.4 JACKETS

A. PVC Plastic

- 1. Jacket: ASTM C921, One piece molded type fitting covers and sheet material, in colors to be selected by the A/E.
 - a. Minimum Service Temperature: -40°F.
 - b. Moisture Vapor Transmission: ASTM E96; 0.002 perm inches.
 - c. Maximum Flame Spread: ASTM E84; 25.
 - d. Maximum Smoke Developed: ASTM E84; 50.
 - e. Connections: Metal tacks covered with pressure sensitive custom color matching vinyl tape.

B. Aluminum Jacket:

- 1. Thickness: 0.018 inch.
- 2. Finish: Smooth.
- 3. Metal Jacket Bands: 3/8 inch wide; 0.018 inch thick aluminum.
- 4. Weatherproof Joints.

2.5 PREFORMED THERMAL JACKETS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

- 1. ThermaXX, LLC. (Basis o Design)
- 2. Fit Tight Covers
- 3. UniTherm
- 4. Or equal as approved by the Professional

B. Materials:

- 1. All insulation materials shall be non-asbestos
- 2. Material layers shall be selected based on Dry location profile and operating temperature of 100-349°F for HHW and 350-424°F for Steam from the "Jacket Material Selections" table:

Layer	Name	Description
Jacket	EJ	PTFE Fiberglass Composite, 16.5 oz/yd ² , rated to 550°F
Jacket	Teflon	Laminated PTFE (Pure Teflon) , 13.5 oz/yd ² , rated to 600°F
Jacket	Silicone	Silicone Fiberglass Composite Jacketing, 17 oz/yd ² , rated to 450°F
Thread	Kevlar Thread	Kevlar, 0.114" diameter, 35lb breakpoint, rated to 800°F

Insulation	Utilicore	Needled fiberglass, 5 lb/ft ³ , rated to 1000°F
Insulation	Tempmat	Needled fiberglass, 9-11 lb/ft ³ , rated to 1200°F
Insulation	Pyrogel	Pyrogel XT-E
Insulation	CP	Ceramic Paper
Fasteners	Nylon Straps	Nylon with D-Rings, Velcro
Fasteners	Teflon Straps	Laminated PTFE with D-Rings, Velcro
Fasteners	EJ Straps	PTFE Fiberflass Composite with D-Rings, Velcro
Seal Flaps	Hybrid 7	Hybrid 7.0 (rated to 600°F) with Kevlar cord (rated to 700°F)

Table 1: Jacket Material Selections

C. Jacket Materials per Operating Temperature for Dry Locations:

	100-349°F	350-424°F
<i>Jacket - Hot Side</i>	Silicone	Silicone
<i>Thread</i>	Kevlar Thread	Kevlar Thread
<i>Insulation Layer 1</i>	1" Tempmat	1" Utilicore
<i>Insulation Layer 2</i>	-	0.25" CP or 5mm Pyrogel
<i>Jacket - Cold Side</i>	Silicone	Silicone
<i>Fasteners</i>	Nylon Straps	Nylon Straps
<i>Seal Flaps</i>	Hybrid 7.0	Hybrid 7.0

D. Construction:

1. Sewn with lock stitch at a minimum of 4 to 6 stitches per inch. Jackets shall be sewn using specified thread in section **Error! Reference source not found.**(B). The thread must be able to withstand the skin temperatures without degradation.
2. Hog rings, staples and wire are not acceptable methods of closure.
3. No raw cut jacket edges shall be exposed after install.
4. Jackets shall be fastened using a combination of hook and loop (Velcro), straps, and D-rings depending on application temperature.
5. The insulation shall be designed to minimize the convection current in the space between the hot metal surface and the inner layer of insulation.
6. All jacket pieces which match mating seams must include an extended 2" flap constructed from the exterior fabric (or equivalent) and shall be secured using hook & loop closure (i.e. Velcro®) parallel to the seam or straps and/or D-Rings depending on application temperature.
7. Insulation shall be sewn as integral part of the jacket to prevent shifting of the insulation. Insulation pins are NOT an allowable method of preventing the insulation from shifting and shall NOT be used.
8. Steam Trap Jackets must be constructed in a box shape for removal and replacement inspection ease.

E. Identification, Labelling, and Management:

1. Provide a permanently attached Laser Etched Anodized Aluminum nameplate (2" x 3.5") SLATE tag on each jacket to identify its location and item number. Each nameplate must have a Laser Etched QR code linking to a website that contains the following information about each individual jacket:

- Item Number
- Location Details
- Application Type
- Operating Pressure
- Component Type
- Component Size
- Jacket Min and Max Temp
- Insulation Thickness
- ANSI Class or NPT
- Install Date
- Install Photo
- Component Maintenance History
- Jacket O&M History

F. JACKET PERFORMANCE & INSULATION THICKNESS:

1. Insulation thickness: Incorporate thickness as required for Touch Temperature

- Touch Temperature (Exterior) of all jackets < 120°F

G. ITEMS TO BE JACKETED INCLUDING BUT NOT LIMITED TO:

1. HHW

- GATE VALVES
- GLOBE VALVES
- BALL VALVES
- WYE STRAINERS
- CHECK VALVES
- CONTROL VALVES

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.
- C. Verify that heat tracing has been installed and tested.

3.02 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. On exposed piping, locate insulation and cover seams in least visible locations.
- C. Chilled Water, heating hot water, domestic water, steam piping systems:
 1. Provide vapor barrier jackets, factory applied.

2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe.
3. PVC jacket and fitting covers for indoor piping, aluminum jacket for roof piping and fittings. Fit jackets to match piping insulation at fittings, valves, reducers, etc. Match existing colors.
4. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Refer to Article D below.
5. Insulate entire system including fittings, valves, unions, flanges, immersion wells, flow meters, vents, and drains.
6. Provide cellular foam insulation on butterfly valve stems.
7. Provide removable covers around flanges for flow meters.
8. Refer to Article F below.

D. Inserts and Shields:

1. Application: Piping 1½ inches diameter or larger.
2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts. Size as required by insert material manufacturer's requirements based on support load.
3. Insert Location: Between support shield and piping and under the finished jacket.
4. Insert Configuration: Minimum 12 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
5. Insert Material: Trymer 6000

E. Finish insulation at supports, protrusions, and interruptions.

F. Insulation shall be tight fitting.

G. Patch/repair insulation on existing piping where connected to the system under this contract, and seal vapor tight.

3.03 GLASS FIBER INSULATION SCHEDULE

	PIPING SYSTEMS	PIPE SIZE	THICKNESS
A.	Heating Hot Water:	<2"	1-1/2"
B.	Heating Hot Water:	1-1/2" and Above	2"
C.	Cooling Coil Condensate:	All	1"

3.04 CELLULAR FOAM

A.	Component	Pipe Size	Thickness
	Refrigerant Piping	--	1"

END OF SECTION 230703

SECTION 23 07 09

EQUIPMENT INSULATION

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 SECTION INCLUDES

- A. Equipment insulation.
- B. Covering.

1.03 RELATED SECTIONS

- A. General Conditions of the Construction Services Agreement.
- B. Division 01 - All Sections.
- C. Section 20 05 90 – Plant Mechanical Paints and Coatings.
- D. Section 20 05 00 - General Requirements.
- E. Section 20 05 10 - Definitions.
- F. Section 20 05 53 - Identification.
- G. Section 23 21 16 - Hydronic Specialties.
- H. Section 23 21 23 – Hydronic Piping.
- I. Section 23 57 00 – Heat Exchangers
- J. Section 23 73 00 – Indoor Air handling Units

1.04 REFERENCES

- A. ASTM C177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
- B. ASTM C195 - Mineral Fiber Thermal Insulation Cement.
- C. ASTM C335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.
- D. ASTM C449 - Mineral Fiber Hydraulic-setting Thermal Insulating and Finishing Cement.
- E. ASTM C518 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- F. ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.
- G. ASTM C553 - Mineral Fiber Blanket and Felt Insulation.
- H. ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.
- I. ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.
- J. ASTM E84 - Surface Burning Characteristics of Building Materials.
- K. ASTM E96 - Water Vapor Transmission of Materials.
- L. NFPA 255 - Surface Burning Characteristics of Building Materials.
- M. UL 723 - Surface Burning Characteristics of Building Materials.

1.05 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Product Data: Provide product description, list of materials and thickness for equipment scheduled.

- C. Samples: Submit two samples of any representative size illustrating each insulation type.
- D. Shop Drawing: Detail fabrication of removable, chiller end plate insulation covers.
- E. Manufacturer's Installation Instructions: Indicate procedures that ensure acceptable workmanship and installation standards will be achieved.

1.06 QUALITY ASSURANCE

- A. Materials: Flame spread/smoke developed rating of 25/50 in accordance with NFPA 255.

1.07 QUALIFICATIONS

- A. Applicator: Company specializing in performing the work of this section with minimum three years experience.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01.
- B. Deliver materials to site in original factory packaging, labeled with manufacturer's density and thickness.
- C. Store insulation in original wrapping and protect from weather and construction traffic.
- D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.09 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 GLASS FIBER, SEMI-RIGID

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Schuller (Basis of Design)
 - 2. Owens Corning.
 - 3. Knauf.
 - 4. Or equal as approved by the Professional
- B. Insulation: ASTM C553; semi-rigid, noncombustible.
 - 1. 'K' value : ASTM C335, 0.24 at 75°F.
 - 2. Maximum service temperature: 500°F.
 - 3. Maximum moisture absorption: 0.2 percent by volume.
 - 4. Density: 2.0 lb/cu ft density.
- C. Factory Applied Vapor Barrier Jacket

1. ASTM C921, kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
2. Moisture vapor transmission: ASTM E96; 0.02 perm.
3. Secure with outward clinch expanding staples and vapor barrier mastic and ½" x 0.018" stainless steel bands on 12" centers.

D. Vapor Barrier Lap Adhesive

1. Foster Spark - FAS 85-20; NFPA 90A & 90B, suitable for field painting.
2. Compatible with insulation.

E. Insulating Cement/Mastic

1. Foster Spark - FAS 85-20; NFPA 90A & 90B, suitable for field painting.
2. ASTM C195; hydraulic setting on mineral wool.

2.02 GLASS FIBER, RIGID

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

1. Schuller (Basis of Design)
2. Owens-Corning.
3. Knauf
4. Or equal as approved by the Professional

B. Insulation: ASTM C612; rigid, noncombustible.

1. 'K' value: ASTM C335, 0.24 at 75°F.
2. Maximum service temperature: 450°F.
3. Maximum moisture absorption: 0.1 percent by volume.
4. Density: 2.25 lb/cu ft density.

C. Factory Applied Vapor Barrier Jacket

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
2. Moisture vapor transmission: ASTM E96; 0.02 perm.
3. Secure with self-sealing longitudinal laps and butt strips.

D. Vapor Barrier Lap Adhesive

1. Foster Spark - FAS 85-20; NFPA 90A & 90B, suitable for field painting.
2. Compatible with insulation.

E. Insulating Cement/Adhesive

1. Foster Spark - FAS 85-20; NFPA 90A & 90B, suitable for field painting.
2. ASTM C195; hydraulic setting on mineral wool.

2.03 CELLULAR FOAM

A. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.

1. 'K' value: ASTM C177 or C518; 0.27 at 75°F.
2. Minimum service temperature: -40°F.
3. Maximum service temperature: 220°F.

4. Maximum moisture absorption: ASTM D1056; 1.0 percent (pipe) by volume, 1.0 percent (sheet) by volume.
5. Moisture vapor transmission: ASTM E96; 0.20 perm inches.
6. Maximum flame spread: ASTM E84; 25.
7. Maximum smoke developed: ASTM E84; 50.
8. Connection: Waterproof vapor barrier adhesive.
9. Custom color selected by Architect.

B. Elastomeric Foam Adhesive

1. Air dried, contact adhesive, compatible with insulation.

2.04 JACKETS

A. Field Applied Fabric Jacket: UL listed.

1. Fabric: ASTM C921, 9 oz/sq yd, Foster Mast-A-FAB cloth membrane covered with dilute fire retardant lagging adhesive.
2. Lagging Adhesive
 - a. Foster Modular 60-95 coating and mastic with custom color selection.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that equipment has been tested before applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. Do not insulate factory insulated equipment.
- C. On exposed equipment, locate insulation and cover seams in least visible locations.
- D. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
- E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.
- F. Finish insulation at supports, protrusions, and interruptions. Extend insulation vertically down supports on chilled piping stanchions.
- G. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.
- H. Install insulation on strainers, heat exchanger, chillers, and covers equipment requiring access for maintenance, repair, or cleaning, in such a manner that it can be easily removed and replaced without damage.

3.03 TOLERANCE

- A. Substituted insulation materials shall provide thermal resistance within 10 percent at normal conditions, as materials indicated.

3.04 PUMP INSULATION

- A. Fabricate and install two-piece, 20 gauge, 316 stainless steel enclosure lined inside with 1 " thick cellular foam insulation. Cellular foam insulation shall be applied to all inside surfaces using adhesive. Enclosure shall completely enclose pump. Coupling and motor shall not be insulated.
- B. Provide hole for air vents, gauge piping, and drains to outside of enclosure. Seal all openings and edges/interfaces air tight to prevent condensation. Corners shall be rounded. All seams shall be welded.
- C. Enclosure shall have turned in flanges with joint sealed all around.
- D. Closure shall be by a minimum of eight (8) heavy duty latches.
- E. Internal edges of enclosure shall be reinforced with 1" x 1" x 1/8"" thick stainless steel angles.

3.05 INSULATION SCHEDULE

SYSTEMS	INSULATION	THICKNESS
Heating Water Pumps	Cellular Foam (Semi-Rigid)	1.0"

END OF SECTION 230709

SECTION 23 07 10

DUCTWORK 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 SECTION INCLUDES

- A. Glass Fiber, Rigid
- B. Glass Fiber, Flexible

1.3 RELATED SECTIONS

- A. Section 20 00 01 - General Requirements.
- B. Section 20 00 02 - Definitions.

1.4 REFERENCES

- A. ASTM C518 -Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- B. ASTM C553 - Mineral Fiber Blanket and Felt Insulation.
- C. ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.
- D. ASTM E84 - Surface Burning Characteristics of Building Materials.
- E. ASTM E96 - Water Vapor Transmission of Materials.
- F. NFPA 255 - Surface Burning Characteristics of Building Materials.
- G. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- H. UL 723 - Surface Burning Characteristics of Building Materials.

1.5 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Product Data: Provide product description, list of materials and thickness for each service, and locations.
- C. Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.6 QUALITY ASSURANCE

- A. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, and UL 723.

1.7 QUALIFICATIONS

- A. Applicator: Company specializing in performing the work of this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01.
- B. Deliver materials to site in original factory packaging, labeled with manufacturer's density and thickness.
- C. Store insulation in original wrapping and protect from weather and construction traffic.
- D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.1 GLASS FIBER, RIGID

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Manville 800 Series Spin-Glass, Type 814.
 - 2. Owens-Corning.
 - 3. Knauf.
 - 4. Or equal as approved by the Professional
- B. Insulation: ASTM C612; rigid, noncombustible.
 - 1. 'K' value: ASTM C335, 0.23 at 75°F.
 - 2. Maximum service temperature: 450°F.
 - 3. Maximum moisture absorption: less than 1.0 percent by volume.
 - 4. Density: 3.0 lb./cu ft density.
- C. Vapor Barrier Jacket
 - 1. Foil-Serim-Kraft (FSK) or All-Purpose (ASJ) as indicated.
 - 2. Moisture vapor transmission: ASTM E96; 0.02 perm.
 - 3. Secure with self sealing longitudinal laps and butt strips.

2.2 GLASS FIBER, FLEXIBLE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Manville Microlite, Type EQ.
 - 2. Owens-Corning.
 - 3. Knauf.
 - 4. Or equal as approved by the Professional
- B. Insulation: ASTM C553; flexible, noncombustible.
 - 1. 'K' value: ASTM C518, 0.27 at 75°F and 25% compressed material.
 - 2. Maximum service temperature: 250°F.
 - 3. Maximum moisture absorption: 0.2 percent by volume.
 - 4. Density: 1.5 lb./cu ft.
- C. Vapor Barrier Jacket
 - 1. Aluminum foil facing reinforced with glass fiber yarn mesh and bonded to Kraft paper (FSK).
 - 2. Moisture vapor transmission: ASTM E96; 0.02 perm.
 - 3. Secure with longitudinal laps and butt joints with outward clinching staples and self sealing pressure sensitive tape with matching facing.
 - 1. staples and self sealing pressure sensitive tape with matching facing.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that ductwork has been tested before applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. Insulated ductwork conveying air above and/or below ambient temperature:
 - 1. Provide insulation with vapor barrier jackets.
 - 2. Finish with tape and vapor barrier jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, expansion joints. Where service access is required, bevel and seal ends of insulation.

3.3 TOLERANCE

- A. Substituted insulation materials shall provide thermal resistance within 10 percent at normal conditions, as materials indicated.

3.4 GLASS FIBER DUCTWORK INSULATION SCHEDULE

<u>DUCTWORK</u>	<u>THICKNESS</u>	<u>TYPE</u>	<u>FINISH</u>
Exterior Supply, Return and Exhaust Air Ducts	2"	Rigid	ASJ (Alumaguard Jacketing)
Exposed Supply, Return and Exhaust Air Ducts	1-1/2"	Rigid	ASJ
Concealed Supply And Exhaust Ducts	1-1/2"	Flexible	Foil Faced
Supply and Return Ducts in Mechanical Rooms	1-1/2"	Rigid	Foil-Faced

END OF SECTION 230710

SECTION 23 08 00

COMMISSIONING OF MECHANICAL 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. Commissioning description.
 - 2. Commissioning responsibilities.
- B. Related Sections:
 - 1. Division 23 – All Sections

1.3 REFERENCES

- A. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE Guideline 1 - The HVAC Commissioning Process.
- B. Building Commissioning Association:
 - 1. BCA - Commissioning Handbook.
- C. National Environmental Balancing Bureau:
 - 1. NEBB - Procedural Standards for Building Systems Commissioning.
- D. Testing Adjusting and Balancing Bureau:
 - 1. TABB - Commissioning Manual.

1.4 COMMISSIONING DESCRIPTION

- A. Commissioning process includes the following tasks:
 - 1. Controls system testing and sequencing of equipment and systems.
 - 2. Control system verification checks.
 - 3. Assistance in functional performance testing to verify control system performance.
 - 4. Provide qualified personnel to assist in commissioning tests, including seasonal testing.
 - 5. Complete and endorse functional performance test checklists provided by Commissioning Authority to assure control systems are fully operational and ready for functional performance testing.
 - 6. Provide equipment, materials, and labor necessary to correct deficiencies found during commissioning process to fulfill contract and warranty requirements.
 - 7. Provide operation and maintenance information and record drawings to Commissioning Authority for review verification and organization, prior to distribution.
 - 8. Provide assistance to Commissioning Authority to develop, edit, and document system operation descriptions.

9. Provide training for systems specified in this Section with coordination by Commissioning Authority.
- B. Equipment and Systems to Be Commissioned:
 1. New control systems (MEC, interconnection wiring, sequences, etc.) and integration from existing I/O panels thru to the Operations Control Center.
 2. New HVAC systems.
 3. New Metering.
 4. New Plumbing systems
- C. The following is a partial list of equipment that may be included in this Commissioning:
 1. Control Systems Integration - PLCs and SCADA.
 2. RTUs.
 3. ERVs
 4. Boilers.
 5. Pumps
 6. Terminal Units.
 7. Unit Heaters.
 8. Domestic Water Heaters
 9. Metering
 10. Mini-Splits.
 11. Dehumidifiers.
 12. Lighting Controls.

1.5 COMMISSIONING SUBMITTALS

- A. Section 01 91 00 - Commissioning: Requirements for commissioning submittals.
- B. Draft Forms: Submit draft of system verification form and functional performance test checklist.
- C. Test Reports: Indicate data on system verification form for each piece of equipment and system as specified.
- D. Field Reports: Indicate deficiencies preventing completion of equipment or system verification checks equipment or system to achieve specified performance.

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record revisions to equipment and system documentation necessitated by commissioning.
- C. Operation and Maintenance Data: Submit revisions to operation and maintenance manuals when necessary revisions are discovered during commissioning.

1.7 QUALITY ASSURANCE

- A. Perform Work in accordance with ASHRAE Guideline 1 requirements.
- B. Maintain one copy of each document on site.

1.8 COMMISSIONING RESPONSIBILITIES

A. Equipment or System Installer Commissioning Responsibilities:

1. Attend commissioning meetings.
2. Ensure temperature controls installer performs assigned commissioning responsibilities as specified below.
3. Provide instructions and demonstrations for Owner's personnel.
4. Ensure subcontractors perform assigned commissioning responsibilities.
5. Ensure participation of equipment manufacturers in appropriate startup, testing, and training activities when required by individual equipment specifications.
6. Develop startup and initial checkout plan using manufacturer's startup procedures and functional performance checklists for equipment and systems to be commissioned.
7. Perform and document completed startup and system operational checkout procedures, providing copy to Commissioning Authority.
8. Provide manufacturer's representatives to execute starting of equipment. Ensure representatives are available and present during agreed upon schedules and are in attendance for duration to complete tests, adjustments and problem-solving.
9. Coordinate with equipment manufacturers to determine specific requirements to maintain validity of warranties.
10. Provide personnel to assist Commissioning Authority during equipment or system verification checks and functional performance tests.
11. Prior to functional performance tests, review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during tests.
12. Prior to startup, inspect, check, and verify correct and complete installation of equipment and system components for verification checks included in commissioning plan. When deficient or incomplete work is discovered, ensure corrective action is taken and re-check until equipment or system is ready for startup.
13. Provide factory supervised startup services for equipment and systems as specified in individual Sections. Coordinate work with manufacturer and Commissioning Authority.
14. Perform verification checks and startup on equipment and systems as specified.
15. Assist Commissioning Authority in performing functional performance tests on equipment and systems as specified.
16. Perform operation and maintenance training sessions scheduled by Commissioning Authority.
17. Conduct control system orientation and inspection.

B. Building Controls Installer Commissioning Responsibilities:

1. Attend commissioning meetings.
2. Review design for ability of systems to be controlled including the following:
 - a. Confirm proper hardware requirements exist to perform functional performance testing.
 - b. Confirm proper safeties and interlocks are included in design.
 - c. Review sequences of operation and obtain clarification from Engineer and supplement sequences to define control system responses to reduction in loads, tripping of equipment, alarms and graphics.
 - d. Indicate delineation of control listing Plant Control Systems (PCS) monitor points and PCS adjustable control points.
3. Inspect, check, and confirm proper operation and performance of control hardware and software.
4. Submit proposed procedures for performing control system point-to-point checks to Commissioning Authority and Engineer.
5. Inspect check and confirm operation of control system input and output device operation through point-to-point checks.

6. Perform training sessions to instruct Owner's personnel in hardware operation, software operation, programming, and application in accordance with commissioning plan and requirements of individual Sections.
7. Demonstrate system performance and operation to Commissioning Authority during functional performance tests including each mode of operation.
8. Provide control system technician to assist during Commissioning Authority verification check and functional performance testing.
9. Provide control system technician to assist testing, adjusting, and balancing agency during performance of testing, adjusting, and balancing work.
10. Assist in performing operation and maintenance training sessions scheduled by Commissioning Authority.

1.9 COMMISSIONING MEETINGS

- A. Section 01 91 00 - Commissioning: Requirements for commissioning meetings.
- B. Attend initial commissioning meeting and progress commissioning meetings as required by Commissioning Authority.

1.10 SCHEDULING

- A. Section 01 30 00 - Administrative Requirements: Requirements for scheduling.
- B. Prepare schedule indicating anticipated start dates for the following:
 1. Control system checkout.
 2. Operation and maintenance manual submittals.
 3. Training sessions.

1.11 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Notify Commissioning Authority minimum of four weeks in advance of the following:
 1. Scheduled control system checkout.

Not Used.

PART 2 EXECUTION

2.1 FIELD TESTS AND INSPECTIONS

- A. Seasonal Sensitive Functional Performance Tests:
 1. Be responsible to participate in initial and alternate peak season test of systems required to demonstrate performance.

END OF SECTION 230800

SECTION 23 09 00

INSTRUMENTATION

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 SECTION INCLUDES

- A. Pressure gages and pressure gage taps.
- B. Thermometers and thermometer wells.
- C. Room Sensors.
- D. Flow meters.

1.02 RELATED SECTIONS

- A. General Conditions of the Construction Services Agreement.
- B. Division 01 - All Sections.
- C. Section 20 05 01 – General Requirements.
- D. Section 20 00 02 – Definitions.
- E. Section 20 05 31 – Supports and Anchors.
- F. Section 20 05 53 – Identification.
- G. Section 23 21 13 – Hydronic Piping.
- H. Section 23 21 16 – Hydronic Piping Specialties.
- I. Section 23 09 25 – Systems Integration.
- J. Section 23 09 23 – Direct Digital Control System for HVAC.
- K. Section 23 09 93 – Sequence of Operations for HVAC.

1.03 REFERENCES

- A. ASME B40.1 - Gages - Pressure Indicating Dial Type - Elastic Element.
- B. ASME MFC-3M - Measurement of Fluid Flow in Pipes Using Orifice, Nozzle and Venturi.
- C. ASTM D2458 - Method of Flow Measurement by The Venturi Motor Tube.
- D. ASTM E1 - Specification for ASTM Thermometers.
- E. ASTM E77 - Verification and Calibration of Liquid-in-Glass Thermometers.
- F. AWWA C700 - Cold Water Meters - Displacement Type.

- G. AWWA C701 - Cold Water Meters - Turbine Type for Customer Service.
- H. AWWA C702 - Cold Water Meters - Compound Type.
- I. AWWA C706 - Direct Reading Remote Registration Systems for Cold Water Meters.
- J. AWWA M6 - Water Meters - Selection, Installation, Testing, and Maintenance.
- K. FS-GG-G-76 - Gages, Pressure and Vacuum, Dial Indicating (for Air, Steam, Oil, Water, Ammonia, Chloro-Fluorohydrocarbon Gases, and Compressed Gases).
- L. ISA RP 3.2 - Flange Mounted Sharp Edged Orifice Plates for Flow Measurement

1.04 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Product Data: Include list which indicates use, operating range, total range and location for manufactured components.
- C. Submit manufacturer's installation instructions under provisions of Division 01.

1.05 PROJECT RECORD DOCUMENTS

- A. Submit documents under provisions of Division 01.
- B. Accurately record actual locations of instrumentation.

1.06 ENVIRONMENTAL REQUIREMENTS

- E. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

1.07 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Division 01.
- B. Include installation instruction, assembly views, lubrication instructions, and replacement parts list.

PART 2 PRODUCTS

2.01 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - i. Noshok, Inc. Series 300 (Basis of Design)
 - ii. Dwyer
 - iii. Watts
 - iv. Or equal as approved by the Professional
- B. ASME B40.1, 4½ inch diameter die cast brass case, phosphor bronze bourdon tube, brass and nickel silver movement, brass socket, black scale on white background, one percent full scale accuracy, scale calibrated in psi, glycerine filled.

2.02 PRESSURE GAGE TAPS

- A. Valve: Ball valve. Refer to Section 23 21 13.
- B. Pulsation Damper: Pressure snubber, brass with ½ inch connections, Model 1350, manufactured by Noshok, Inc.

2.03 STEM TYPE THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - v. Noshok, Inc. Series 320 (Basis of Design)
 - vi. Dwyer
 - vii. Watts
 - viii. Or equal as approved by the Professional
- B. 5 inch diameter scale, 304 stainless case with electric polished 304 stainless steel bezel, black aluminum pointer, 304 stainless steel stems, adjustable angle connection. Accuracy shall be ± 1% of full scale. Scale shall be 0-100°F. Stem size shall be nearest to ½ diameter of pipe.

2.04 THERMOMETER WELLS

- A. Socket: 316 stainless steel separable sockets for thermometer stems with extensions for insulation as required. Provide with cap and chain for spare wells.

2.05 ROOM SENSORS

- A. All Room Sensors shall provide Temperature measurements, Addressable, push button occupancy override and setpoint adjustment, as manufactured by ALC.
 - i. Thermostat Range: 32°F to 120°F
 - ii. Thermostat Accuracy: ±1.0°F

2.06 FLOW METERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - i. Sensus Omni T2 (Basis of Design)
 - ii. Rosemount
 - iii. Yokogawa
 - iv. Onicon
 - v. Or equal as approved by the Professional
- B. Flow Tube
 - i. Non-wetted parts
 - 1. AISI Type 304 SST sensor, carbon steel flanges, and welded steel housing
 - ii. Wetted parts
 - 2. PTFE lining, and titanium electrodes
 - iii. Process Connections
 - 3. ASME B16.5 Class 150
 - iv. Two ½-14 NPT connections with number 8 screw terminals in the terminal enclosure for electrical wiring.
 - v. 316L SST grounding ring between flange and sensor face on both sides of sensor, and grounding electrode.
 - vi. 316L SST lining protector between flange and sensor face on both ends of the sensor.

- vii. -20 to 350 F process temperature limits, -30 to 150 F operating ambient temperature limits.
 - viii. Polyurethane outer coating.
- C. Transmitter
- i. 9-250 V AC, 60 Hz power supply
 - ii. Process signals from fluids traveling between 0.04 and 39 ft/s in both directions with full scale continuously adjustable between -39 and 39 ft/s.
 - iii. 500mA transmitter coil drive current and 350 ohm maximum sensor coil resistance.
 - iv. -20 to 140 F operating ambient temperature limits, 0 to 100% RH to 150 F
 - v. Type 4X, IEC 60529 enclosure rating, polyurethane paint, and rubber cover gasket.
 - vi. Hart Protocol – 4-20mA, switch-selectable as internally or externally powered 5 to 24 V DC, 0 to 1000 ohm load.
 - vii. Transmitter shall be capable of indication upon transmitter fault, flow limits, totalizer limit, diagnostic status, capable of an analog and pulse output test commanded to supply either a current between 3.5 and 23 mA or a frequency between 1 and 10,000 Hz.
- D. Performance
- i. System composite accuracy of +/- 0.25% of rate +/- from 0.04 to 6 ft/s and +/- 0.25% of rate +/- 1.5 mm/sec above 6 ft/s.
 - ii. Repeatability of +/- 0.1% of reading
 - iii. 50 ms maximum response time to step change in output
 - iv. Stability of +/- 0.1% of rate over six months
 - v. +/- 0.25% change over operating temperature range

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install one pressure gage per pump, installing taps on suction and discharge of pump. Pipe to gage as indicated.
- C. Install pressure gages with pulsation dampers. Provide ball valve to isolate each gage as indicated.
- D. Install thermometers in piping systems in sockets. Enlarge pipes smaller than 2 ½ inch for installation of thermometer sockets.
- E. Install thermometer sockets adjacent to controls system RTD "Pipe Well". Refer to Sections 23 09 00 and 23 09 23.
- F. Install gages and thermometers in locations where they are easily read from normal operating level.
- G. Install spare wells as indicated.
- H. Fill wells 1/3 full with heat conducting grease.
- I. Provide interconnecting wiring between meter and meter instrumentation.
- J. Install and pipe flow elements per Manufacturer's instructions.
- K. Flow elements shall be installed with taps at horizontal plane at side of piping, with ball valves and unions on each line at the element. Connect elements to manometer with ½ inch hard copper, type "L" tubing, with continuous slope to manometer of not less than ½ inch per foot.

3.02 EXAMINATION

- A. Verify that systems are ready to receive work.
- B. Beginning of installation means installer accepts existing conditions.
- C. Coordinate all work.

3.03 MANUFACTURER'S FIELD SERVICES

- A. Prepare and start systems. Verify control components operate properly and perform desired functions.

3.04 DEMONSTRATION

- A. Provide systems demonstration.
- B. Demonstrate complete operation of systems, including sequence of operation after Date of Substantial Completion. Provide one eight (8) hour day on site for demonstration of systems.

END OF SECTION 230900

SECTION 23 09 03

CONTROL 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 WORK INCLUDED

- A. This section specifies the requirements for all work necessary for fabrication of the control panel. This shall include component installation, labeling, wiring, relays, PLC modules, HMI panels, terminal blocks, power supplies, and other items necessary to fulfill the requirements of the specific panels involved. The contractor shall provide PLC IO panel as-built drawings.
- B. The controls are to be provided through ALC.
- C. The vendor will provide typical panel layout, bill of materials, nameplate schedule, and input/output (I/O) wiring drawings/schedules.
- D. The installation of all equipment, instruments, and wiring shall allow for adequate acceptable clearance for servicing, replacement, and maintenance. Locally mounted instruments shall be installed in such a manner as to prevent interference with mechanical installations and to ensure readability from the aisles or operating areas. The vendor shall furnish and install all material and equipment indicated, specified and/or required to provide a complete and operable panel.
- E. Any departures from the contract documents deemed necessary by the vendor shall be submitted to the engineer for approval. No such departures shall be made without the prior written approval of the engineer.
- F. Contractor shall follow campus and DMVA I/O tagging requirements for all panels.
- G. Panels shall include area for installation of field interposing relays. Provide necessary mounting hardware in panels.

1.3 RELATED WORK

- A. This section shall be used in conjunction with the following related contract documents and specification sections:
 - 1. Division 00 – All Sections
 - 2. Division 01 – All Sections
 - 3. Division 20 – All Sections
 - 4. Division 23 – All Sections
 - 5. Division 26 – All Sections

- B. CAUTION: Use of this section without including all of the above listed items will result in omission of basic requirements.
- C. In the event of conflict regarding requirements for the referenced instrumentation and controls between this Section and all other section, the provisions of this Section will govern.

1.4 DESIGN CRITERIA

- A. Environmental Conditions: Unless otherwise noted, panels shall be suitable for the following environmental conditions:
 - 1. Indoor Environment:
 - a. Temperature: 50 degrees to 200 degrees F.
 - b. Relative Humidity: 10 to 70 percent.
 - c. Enclosure Rating: NEMA 1 unless noted otherwise.
 - d. Classification: nonhazardous.

1.5 WARRANTY

- A. The subcontractor's installation and workmanship shall not violate the equipment vendor's warranties.
- B. The equipment vendor's warranty documentation shall be furnished to the owner.
- C. The subcontractor shall correct all deficiencies noted by the engineer before shipment.
- D. The subcontractor and coating manufacturer shall jointly and severally warrant and guarantee the work against defective workmanship and materials for a period of 1 year commencing on the date of final acceptance of the work.

1.6 REGULATORY REQUIREMENTS

- A. Conform to applicable UBC code for flame/fuel/smoke rating and ventilation requirements for application of finishes.
- B. All wiring shall comply with the requirements of the National Electric Code.

1.7 QUALIFICATIONS

- A. All subcontractor employees who work directly on the panels shall be certified in their respective trades.

1.8 STORAGE AND HANDLING

- A. Throughout the work, the subcontractor shall provide protection for materials and equipment against loss or damage and from the effects of weather. Prior to installation, store items in indoor, dry locations. Provide heating in storage areas for items subject to corrosion under damp conditions.

1.9 SUBMITTALS

- A. Basic submittal requirements shall be in accordance with Section 01 33 00, Submittals. Additional requirements and identified in this section.
- B. Provide the submittal schedule within 6 weeks after award of contract, covering:

1. Hardware catalog information, data, or specification sheets.
 2. Shop drawings (including I/O wiring and all hardware wiring).
 3. Best estimate of completed panel shipments based on Construction Manager's construction schedule.
- C. Advise intent to comply with packaging for shipment as called out in Section 3.85 of these specifications. Any deviation from this procedure must be submitted and approved by the Engineer.
- D. All submittals shall be complete, neat, orderly, indexed, and in accordance with the approved submittal schedule. All components shall be referenced by the tag designations shown on the Drawings.
- E. Incomplete or unclear submittals will be returned to the contractor and shall be revised and resubmitted within a period of 2 weeks.
- F. Provide one set of shop drawings with each panel for field use during construction startup. Provide one set of as-built documentation incorporating all changes made during construction and startup/commissioning.

1.10 PROJECT RECORD DOCUMENTS

- A. Provide panel layout and wiring drawings with design and construction modifications noted. Red shall be used for additions, green for deletions, blue for new notes, and black for existing. These drawings shall be maintained during construction.

PART 2 – PRODUCTS

2.1 FABRICATION SPECIFICATIONS

- A. Control Panels:
1. Panels shall be wall mounted, completely fabricated, panel and door-mounted instruments, PLC I/O swingout wiring arms, and terminal blocks, installed and wired in the subcontractor's shop. All wiring shall be completed and tested prior to shipment. External connections shall be by way of numbered terminal blocks per the drawings.
 2. All connections for future functions shall be wired to numbered terminal blocks. Terminal blocks shall also be grouped to keep ac circuits separate from the dc circuits.
 3. Panels shall have no exposed terminals that may be inadvertently touched (i.e., terminal screws shall be in wells).
 4. Panel Construction:
 - a. Panel cutouts for other devices shall be cut, punched, or drilled, and smoothly finished with rounded edges and only occur on the bottom of the panel.
 - b. Panel shall be provided with fully gasketed front access door where shown. Door shall be provided with locking latches. All locks to be keyed alike. Keys shall be taped to inside of enclosure.
 - c. All components are to be bolted to the back panel using tapped holes of the proper size recommended by the equipment manufacturer. Lock washers are to be used with all bolts and screws. All back panels shall be one piece.
 - d. Control panel electrical:
 1. Power Distribution Within Panels:

- a. Each panel will be provided with one or more 120-Vac, 60-Hz feeder circuits from the associated circuit breaker distribution panels. Provide a terminal board for termination of the wires.
 - b. Power distribution component layout and wiring are per the drawings.
2. Wiring:
- a. All electrical wiring shall be in accordance with the drawings, and the National Electric Code. Wires shall be 600 volt class, PVC or polyethylene insulated stranded copper, and shall be of the sizes required for the current to be carried minimum size 16 THHN for ac power circuits, 16 THHN for dc circuits. Provide hinge wiring for front of panel devices. Wiring shall be wrapped with plastic cable stays. Hinged wiring shall be secured at each end so that any bending or twisting will be around the longitudinal axis of the wire and the bend area shall be protected with a sleeve.
 - b. All interconnecting wires, including spares, between panel mounted equipment and external equipment shall be terminated at numbered terminal blocks. No multiconductor cable allowed.
 - c. Wiring Color Codes:

Wiring Colors shall match ALC standards
 - d. Arrange wiring neatly, cut to proper length, and remove surplus wire. Provide abrasion protection for any wire bundles which pass through holes or across edges of sheet metal.
 - e. Wiring shall not be spliced or tapped.
 - f. Marked with Raychem markers.
 - g. Provide wiring attached to interior side of panel door to house wires for panel front-mounted devices. Provide separate wireways for dc and ac signals.
 - h. All wiring between I/O ports and terminal blocks shall be labeled with I/O number designation.
 - i. Wiring strain relief on hinged panels secured by mechanical means not stick-on harness tie pads.
3. Terminal Blocks: Terminal blocks shall be sectional plastic blocks rated for 600 volts. Terminal shall be double sided and unit shall be capable of accepting wire sizes up to THHN 12. Terminals have permanent, legible identification. Elevate all terminal strips so the top of the smallest terminal on the strip is even with the top of the adjacent element. Specific attention should be given to terminal block model numbers shown on the bill of materials, as special conditions exist for specific terminals. Provide end caps for all terminal strips.
4. Cable from data highway terminals in panel to PLC processor shall be Belden 9463. Obtain sufficient quantity of cable for this purpose and install it in panel.

- e. Nameplates, name tags, and service legends:
 - 1. All components provided under this section shall be provided with permanently mounted nametags bearing the entire ISA tag number of the component. Panel mounted tags shall be plastic.
 - 2. The panel drawings refer to nameplates and service legends. Nameplates are defined as inscribed laminated plastic plates mounted under or near a panel face mounted instrument. Service legends are defined as inscribed laminated plastic integrally mounted on a panel face mounted instrument.
 - 3. Service legends and nameplates shall be engraved, rigid, laminated plastic type with adhesive back. Unless otherwise noted, color shall be white with black letters and letter height shall be minimum 3/8" with 1/4" letters on the drawings.
 - 4. Each panel shall be provided with a face mounted laminated nameplate as specified above. Unless otherwise noted, color shall be white with black letters.
 - 5. Nameplates, nametags, and service legends attached to panels or panel components will be firmly affixed to the panel or components using stainless steel screws.
- f. Wire markers shall be shrink tubing type, electrical identification. Cloth or wraparound adhesive types are not acceptable.
- g. Like items of equipment provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's service.
- h. Provide 25 percent spare terminals in addition to wired terminal.
- i. Provide ground bar for proper shielding of instruments.

B. Cabinets and Enclosures:

- 1. Enclosures shall be manufactured to the following industry standards:
 - a. NEMA Standards Publication IC56, Enclosures for Industrial Controls and Systems.
 - b. UL 508, Industrial Control Equipment.
 - c. CSA Standard C22.2.
 - d. IEC 529, Classification of Degrees of Protection Provided by Enclosures.
- 2. Enclosures shall be general purpose and fabricated from a minimum 14 gauge carbon steel and shall encompass the following features:
 - a. Spot Weld Construction
 - b. Gasketed doors, overlapping where required, open 180°.
 - c. Black quarter turn keylocking handle. All panels shall be keyed alike.
 - d. Butt hinges.
 - e. Ground stud on door and body.
 - f. Print pocket.
 - g. Heavy-duty lifting eyes where required.
 - h. Mounting holes on back of enclosure.
 - i. Standoffs provided for mounting where required.
 - j. Panel supports/brackets.
 - k. Oil-resistant door gasket.
 - l. Collar studs.
 - m. Sub-Panel.
 - n. Sub-Panel mounting hardware included.
 - o. Panel provision for raceway entry. Size, location, and quantity are as shown on the drawings.

- p. GFI receptacle.
- q. ANSI 61 Gray.
- r. NEMA 1.
- s. Made in USA.

2.2 FINISHES – NEW PANELS

A. Work Included:

1. Surface preparation.
2. Application of paint and protective paint/coating systems.
3. Provide continuous ventilation and heating facilities to maintain surface and ambient temperatures above 50 degrees F for 24 hours before, during, and 48 hours after application of finishes unless required otherwise by manufacturer's instructions.
4. The control panel interior and exterior shall be painted unless material is called out as stainless steel.

B. Paint Materials:

1. Paint shall be factory applied dry powder (preferred).
2. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners, and other materials not specifically indicated but required to achieve the finishes specified of commercial quality per manufacturer's recommendations.

C. Preparation – Paint Mixing:

1. Prepare multiple component coatings using all contents of each component container as packaged by the paint manufacturer; no partial batches permitted.
2. Do not use mixed multiple component coatings beyond their pot life; provide small quantity kits for touchup painting and for painting other small areas.
3. Mix only the components specified and furnished by the paint manufacturer.
4. Do not intermix additional components for reasons of color or otherwise, even with the same generic type of coating.
5. Seal paint materials when not in use.
6. Where more than one coat of a material is applied within a given system, alternate color to provide a visual reference that the required number of coats have been applied.

D. Metal Surface Preparation:

1. Surfaces shall be prepared per paint manufacturer's instructions resulting in a surface that is free of rust and grease or oil.
2. Conform to the current Steel Structures Painting Council (SSPC) specifications as follows:
 - a. Solvent Cleaning: SP 1.
 - b. Hand Tool Cleaning: SP 2.
 - c. Power Tool Cleaning: SP 3.
 - d. White Metal Blast Cleaning: SP 5.
 - e. Commercial Blast Cleaning: SP 6.
 - f. Brushoff Blast Cleaning: SP 7.
 - g. Pickling: SP 8.
 - h. Near-White Blast Cleaning: SP 10.

3. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, use wet or vacublast methods. Comply with coating manufacturer's recommendations for wet blast additives and first coat application.
 4. Hand tool clean areas that cannot be cleaned by power tool cleaning.
- E. Application:
1. Apply products in accordance with manufacturer's specifications and as specified herein.
 2. Apply each coat to uniform finish, free of runs, sags, lap marks, air bubbles, and pinholes.
 3. Sand lightly between coats to achieve required finish.
 4. Allow applied coat to dry before next coat is applied.
 5. Paint units to be bolted together and to structures prior to assembly or installation.
 6. Shop Primed Surfaces:
 - a. Damaged Surfaces:
 1. Hand or power sand areas of chipped, peeled, or abraded coatings, feathering the edges.
 2. Spot-prime the areas with the specified primer.
 - b. Prior to application of finish coats, clean shop primed surfaces of all dirt, oil, and grease.
 - c. Provide mist coat, 1 mil dry film thickness of the specified primer.
 - d. After welding, prepare and prime welding holdback areas as required for specified paint system.
- F. Film Thickness:
1. Coverage is listed as either total minimum dry film thickness in mils (MDFT) or the spreading rate in square feet per gallon (SFPG).
 2. Per coat determinations are listed as MDFTPC or SFPGPC.
 3. Number of Coats:
 - a. The number of coats are the minimum required irrespective of the coating thickness.
 - b. Additional coats may be required to obtain the minimum required paint thickness, depending on method of application.
 - c. Do not exceed coating manufacturer's recommendations regarding maximum film build per coat.
- G. Damaged Coating:
1. Damaged Coatings, Pinholes, and Holidays: Edges feathered and repaired in accordance with the recommendations of the paint manufacturer as reviewed by the Engineer.
 2. Repair of Fusion Bonded Coatings: As recommended by the original applicator.
 3. Apply all finish coats, including touchup and damage repair coats in a manner which will present a uniform texture and color matched appearance.
- H. Satisfactory Application:
1. Clean and top coat surfaces with proper finish color and sufficient film thickness.
 2. Secure specific surface preparation information from the coating manufacturer.
 3. Repair any defects in the coating system per written recommendations of the coating manufacturer.

2.3 SEISMIC PROVISIONS

- A. Freestanding panels shall have provisions for securing to the floor to meet local seismic requirements.

PART 3 – EXECUTION

3.1 INSPECTIONS

- A. All materials, equipment, and workmanship shall be subject to inspection at any time by the engineer. Correct any work, materials, or equipment not in accordance with these contract documents or found to be deficient or defective in a manner satisfactory to the engineer at no additional cost.

3.2 PREPARATION

- A. Corrosion Protection: All control panels, enclosures, and other equipment containing electrical or instrumentation and control devices, including spare parts, shall be protected from corrosion through the use of corrosion inhibiting vapor capsules. Prior to shipment, the capsules shall be provided within the shipping containers and equipment as recommended by the capsule manufacturer. During the construction period, the capsules shall be replaced periodically in accordance with the capsule manufacturer's recommendations. All capsules shall be replaced by the contractor just prior to owner's final acceptance of the equipment. The corrosion inhibiting vapor capsules shall be Northern Instruments Model Zerust VC or Hoffman Model A-HCI.
- B. Provide wireway attached to interior side of panel door to house wires for panel front mounted devices, such as switches, lights, indicators. Provide separate wireways for dc and ac signals.
- C. Review existing panels to verify content, capacity, and expansion capability. Expand existing panels prior to installing new panels. Coordinate location of all new panels with the Engineer prior to installation.
- D. Indicate location of new conduits, panels, wiring, etc. on coordination plans being prepared under Division 1.

3.3 TEST AND ADJUST – PREFACTORY – NEW PANELS

- A. At the panel factory, the subcontractor shall perform a continuity test of all wiring to verify conformance of wiring circuits to the Drawings. Discrepancies shall be corrected prior to shipment.
- B. All PLC processor and backplane DIP switches shall be set by the subcontractor.
- C. The subcontractor shall calibrate all instrumentation.
- D. The subcontractor shall provide a written verification of the test showing:
 - 1. Dates and times of tests.
 - 2. Personnel performing tests.
 - 3. Discrepancies found.
 - 4. Date and person performing corrections.

3.4 FACTORY TEST – NEW PANELS

- A. The system integrator will conduct a factory test at the panel shop after the preliminary testing noted above in paragraph 3.6 has been completed by the subcontractor. Provide a schedule indicating when this testing will be accomplished. The factory test will:
 - 1. Check for I/O wiring completeness.
 - 2. Check for PLC-to-PLC communications.
 - 3. Check for remote terminal communications.
- B. The panels shall be tested in groups, and the schedule shall so reflect. Schedule shall be approved by the system integrator and owner at least 3 weeks in advance.
- C. The system integrator will lead the factory test with assistance from the subcontractor. Provide assistance to the system integrator, with a minimum of one person every day the test is conducted. Assume 1 day per two panels is required.
- D. Provide a staging area for the time and space required dedicated to the project in the panel shop for the testing.
- E. Provide temporary 120-Vac power wiring and data highway cabling to each panel and remote terminal.
- F. Provide temporary power connection for both UPS and non-UPS panel power. The system integrator will provide testing documentation sheets for each PLC and LCP and will fill out the sheets and place them in the panel drawing pocket.

3.5 PACKAGING FOR SHIPMENT

- A. The panel shall be wrapped with plastic bubble sheeting prior to crating.
- B. PLC and instrument installation manuals and factory testing sheets shall be enclosed in manila envelopes and secured to the inside of the panel.
- C. All panels shall be mounted in crates for shipment. Panels shall be secured to crates.

END OF SECTION 230903

SECTION 23 09 23

DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1: GENERAL

- 1.0 Stipulations
- 1.1 Section Includes
- 1.2 Products Furnished but Not Installed under This Section
- 1.3 Products Installed but Not Furnished under This Section
- 1.4 Products Not Furnished or Installed under but Integrated with the Work of This Section
- 1.5 Related Sections
- 1.6 Description
- 1.7 Approved Control system Manufacturers
- 1.8 Quality Assurance
- 1.9 Codes and Standards
- 1.10 System Performance
- 1.11 Submittals
- 1.12 Warranty
- 1.13 Ownership of Proprietary Material
- 1.14 Definitions

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 Related Sections

- A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are part of this specification and shall be used in conjunction with this section as part of the contract documents.
- B. The following sections constitute related work:
 - 1. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC
 - 2. Section 23 09 93 - Sequence of Operations for HVAC Controls
 - 3. Section 23 21 16 - Hydronic Piping Specialties
 - 4. Section 23 36 00 - Air Terminal Units
 - 5. Section 26 05 00 – Basic Electrical Requirements
 - 6. Section 26 05 19 - Low Voltage Electrical Power Conductors and Cables
 - 7. Section 26 50 00 - Lighting
 - 8. Section 28 31 00 – Fire Alarm System

1.2 Description

- A. General: The control system shall consist of a high-speed, peer-to-peer network of DDC controllers, a control system server, and a web-based operator interface.
- B. The controls contractor shall extend the existing BAS, located and installed on the campus, with new controls as required to integrate and fully control the new equipment and devices from the existing control system and graphic interface. All new controls shall be an extension of the existing system and be accessible via the existing Campus BAS platform.

- C. Furnish all labor, materials, equipment, and service necessary for a complete and operating temperature control system, utilizing a high-speed, peer-to-peer network of Direct Digital Controls, routers, repeaters, and electronic interfaces and actuation devices, as shown on the drawings and as described herein. All existing control systems, not being replaced under this contract shall remain in place and be extended to incorporate the new systems. The system shall be based on industry standard BACnet protocols as provided by Automated Logic branch facility. Drawings are diagrammatic only. Equipment and labor not specifically referred to here or on the plans, which are required to meet the functional intent, shall be provided without additional cost to the Owner. Performance and capabilities are based on the Automated Logic Facility Management System (FMS).
- D. System software shall be based on a server/thin client architecture, designed around the open standards of web technology. The control system server shall be accessed using a Web browser over the control system network, the owner's local area network, and (at the owner's discretion) over the Internet.
- E. The intent of the thin-client architecture is to provide operators complete access to the control system via a Web browser. No special software other than a web browser shall be required to access graphics, point displays, and trends, configure trends, configure points and controllers, or to download programming into the controllers.
- F. System shall use the BACnet protocol for communication to the operator workstation or web server and for communication between control modules. I/O points, schedules, setpoints, trends and alarms specified in 23 09 93 – "Sequence of Operations for HVAC Controls" shall be BACnet objects.
- G. All new controls shall be integrated into the existing BAS. Provide, under this contract, control system expansion, point assignment and programming required to provide all new control points to the existing BAS and energy manager system. Provide all new graphics and point assignments required to provide a complete integrated control system.
- H. All ATC controls points, both hardware and software, shall be accessible (read/write) from the existing Automated Logic campus system. The controls vendor shall provide all necessary hardware, including open communication (BacNET) routers and all necessary programming required to allow communication between the building system controllers and the Campus wide control system.
- I. Provide all required hardware, software and integration tools required to integrate package roof-top units into the Automated Logic control system. Provide all required wiring needed to tie new units into existing building automation system architecture.
- J. Work described in this section shall be installed, wired, circuit tested, and calibrated by factory-certified and employed technicians qualified for this work and in the regular employment of the temperature control system manufacturer. Installing office shall have a minimum of ten years of installation experience with the manufacturer and shall provide documentation in submittal package verifying longevity of the installing company's relationship with the manufacturer. Supervision, calibration, and checkout of the system shall be performed by the employees of the local factory-owned temperature control contracting field office. Supplier shall have an in-place support facility within 25 miles of the site with technical staff, spare parts inventory, and all necessary test and diagnostic equipment. The Facility Management System (FMS) shall be an extension to the existing Automated Logic control system. Provide all system expansion labor including all necessary programming and graphics required to integrate new control system into existing EBI system.
- K. The FMS building management and control functions to be provided include:
 - 1. Building management and control
 - 2. Monitoring and control of controllers, remote devices, and programmable logic controllers, including sensors, actuators, and environmental delivery systems (room climate control, lighting systems, electrical systems, etc)

3. Operator interface to allow general supervision of room controls
4. Data collection and historization
5. Alarm management
6. Trending
7. Report generation
8. Network integration
9. Data exchange and integration with a diverse range of other computing and facilities systems using industry-standard techniques

1.3 Approved Control system Manufacturers

A. The following are approved control system suppliers, manufacturers, and product lines:

Company	Product Line	Address/Location	Contact
Automated Logic		randy.robertson@carrier.com	cell: 717-798-4066

1. The above item has been approved by the Department as a proprietary item. No other item will be accepted. Section 9.6 and 9.7 of the General Conditions to the Construction Contract does not apply to the above item.
2. The above list does not indicate order of preference. Inclusion on this list does not guarantee acceptance of products or installation. Control systems shall comply with the terms of this specification.
3. The Contractor shall use only operator workstation software, controller software, custom application programming language, and controllers from the corresponding manufacturer and product line unless Owner approves use of multiple manufacturers.
4. Other products specified herein (such as sensors, valves, dampers, and actuators) need not be manufactured by the above manufacturers.

1.4 Quality Assurance

A. Installer and Manufacturer Qualifications

1. Installer shall have an established working relationship with Control System Manufacturer.
2. Installer shall have successfully completed Control System Manufacturer's control system training. Upon request, Installer shall present record of completed training including course outlines.
3. Bids by wholesalers, independent contractors, or franchised dealers shall not be acceptable.
4. All work described in this section shall be installed, wired, circuit tested, and calibrated by factory-certified technicians qualified for this work and in the direct employment of the temperature control system manufacturer.
5. Contractor shall provide 100 percent of all services with company personnel. No portion of services can be subcontracted to others without express written permission of the Owner; with such permission, all specifications, terms, and conditions specified herein shall be the responsibility of the prime Contractor.
6. Mechanical equipment manufacturers desiring to provide DDC-type controls as factory-mounted equipment shall provide a separate bid for their products, less all controls, actuators, valve assemblies, and sensors, which are specified to be provided by the FMS Contractor.

1.5 Codes and Standards

A. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with the current editions in effect 30 days prior to the receipt of bids of the following codes:

1. National Electric Code (NEC)
2. International Building Code (IBC)
 - a. Section 719 Ducts and Air Transfer Openings
 - b. Section 907 Fire Alarm and Detection Systems
 - c. Section 909 Smoke Control Systems
 - d. Chapter 28 Mechanical
3. International Mechanical Code (IMC)
4. International Energy Conservation Code (IECC)
5. ANSI/ASHRAE Standard 135, BACnet - A Data Communication Protocol for Building Automation and Control Systems

1.6 System Performance

- A. 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, PID loops, and similar control logic shall automatically refresh within 6 sec.
 4. Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.
 5. Alarm Response Time. An object that goes into alarm shall be annunciated at the workstation within 45 sec.
 6. 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.
 7. Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
 8. Multiple Alarm Annunciation. Each workstation on the network shall receive alarms within 5 sec of other workstations.
 9. Reporting Accuracy. System shall report values with minimum end-to-end accuracy listed in Table 1.
 10. Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2.

Table-1
Reporting Accuracy

Measured Variable	Reported Accuracy
Space Temperature	±0.5°C (±1°F) (see Note 4)
Ducted Air	±0.5°C (±1°F)
Outside Air	±1.0°C (±2°F)
Dew Point	±1.5°C (±3°F)
Water Temperature	±0.5°C (±1°F)
Delta-T	±0.15° (±0.25°F)
Relative Humidity	±5% RH
Water Flow	±2% of full scale
Airflow (terminal)	±10% of full scale (see Note 1)
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized spaces)	±3% of full scale
Air Pressure (ducts)	±25 Pa (±0.1 in. w.g.)
Air Pressure (space)	±3 Pa (±0.01 in. w.g.)

Water Pressure	±2% of full scale (see Note 2)
Electrical	±1% of reading (see Note 3)
Carbon Monoxide (CO)	±5% of reading
Carbon Dioxide (CO ₂)	±50 ppm

Note 1: Accuracy applies to 10%–100% of scale

Note 2: For both absolute and differential pressure

Note 3: Not including utility-supplied meters

Table 2
Control Stability and Accuracy

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±50 Pa (±0.2 in. w.g.) ±3 Pa (±0.01 in. w.g.)	0–1.5 kPa (0–6 in. w.g.) -25 to 25 Pa (-0.1 to 0.1 in. w.g.)
Airflow	±10% of full scale	
Space Temperature	±1.0°C (±2.0°F)	
Duct Temperature	±1.5°C (±3°F)	
Humidity	±5% RH	
Fluid Pressure	±10 kPa (±1.5 psi) ±250 Pa (±1.0 in. w.g.)	MPa (1–150 psi) 0–12.5 kPa (0–50 in. w.g.) differential

1.7 Submittals

- A. Product Data and Shop Drawings: Meet requirements of Section 01 30 00 on Shop Drawings, Product Data, and Samples. In addition, the contractor shall provide shop drawings or other submittals on hardware, software, and equipment to be installed or provided. No work may begin on any segment of this project until submittals have been approved for conformity with design intent. Provide drawings as AutoCAD 2006 (or newer) compatible files on magnetic or optical disk (file format: .DWG, .DXF, .VSD, or comparable) and three 11" x 17" prints of each drawing. When manufacturer's cutsheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawing shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. Submittal approval does not relieve Contractor of responsibility to supply sufficient quantities to complete work. Submittals shall be provided within 12 weeks of contract award. Submittals shall include:

1. DDC System Hardware
 - a. A complete bill of materials to be used indicating quantity, manufacturer, model number, and relevant technical data of equipment to be used.
 - b. Manufacturer's description and technical data such as performance curves, product specifications, and installation and maintenance instructions for items listed below and for relevant items not listed below:
 - i. Direct digital controllers (controller panels)
 - ii. Transducers and transmitters
 - iii. Sensors (including accuracy data)
 - iv. Actuators
 - v. Valves
 - vi. Relays and switches
 - vii. Control panels
 - viii. Power supplies
 - ix. Batteries
 - x. Operator interface equipment
 - xi. Wiring
 - c. Wiring diagrams and layouts for each control panel. Show termination numbers.

- d. Schematic diagrams for all field sensors and controllers. Provide floor plans of all sensor locations and control hardware. Riser diagrams showing control network layout, communication protocol, and wire types.
- 2. Central System Hardware and Software
 - a. A complete bill of material of equipment used indicating quantity, manufacturer, model number, and relevant technical.
 - b. Manufacturer's description and technical data such as product specifications and installation and maintenance instructions for items listed below and for relevant items furnished under this contract not listed below:
 - i. Central Processing Unit (CPU) or web server
 - ii. Monitors
 - iii. Keyboards
 - iv. Power supplies
 - v. Battery backups
 - vi. Interface equipment between CPU or server and control panels
 - vii. Operating System software
 - viii. Operator interface software
 - ix. Color graphic software
 - x. Third-party software
 - c. Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show interface wiring to control system.
 - d. Network riser diagrams of wiring between central control unit and control panels.
- 3. Controlled Systems
 - a. Riser diagrams showing control network layout, communication protocol, and wire types.
 - b. A schematic diagram of each controlled system. The schematics shall have all control points labeled with point names shown or listed. The schematics shall graphically show the location of all control elements in the system.
 - c. A schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.
 - d. An instrumentation list (Bill of Materials) for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
 - e. A mounting, wiring, and routing plan-view drawing. The design shall take into account HVAC, electrical, and other systems' design and elevation requirements. The drawing shall show the specific location of all concrete pads and bases and any special wall bracing for panels to accommodate this work.
 - f. A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system.
 - g. A point list for each control system. List I/O points and software points specified in Section 23 09 93. Indicate alarmed and trended points.
- 4. Quantities of items submitted shall be reviewed but are the responsibility of the Contractor.
- 5. Description of process, report formats, and checklists to be used in Section 23 09 23 Article 3.17 (Control System Demonstration and Acceptance).
- 6. BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of controller and operator interface.

B. Schedules

- 1. Within one month of contract award, provide a schedule of the work indicating the following:
 - a. Intended sequence of work items
 - b. Start date of each work item

- c. Duration of each work item
 - d. Planned delivery dates for ordered material and equipment and expected lead times
 - e. Milestones indicating possible restraints on work by other trades or situations
- 2. Monthly written status reports indicating work completed and revisions to expected delivery dates. Include updated schedule of work.
- C. Project Record Documents. Upon completion of installation, submit three copies of record (as-built) documents of the documents shall be submitted for approval prior to final completion and shall include:
 - 1. Project Record Drawings. As-built versions of submittal shop drawings provided as AutoCAD 2006 (or newer) compatible files on magnetic or optical media (file format: .DWG, .DXF, .VSD, or comparable) and as 11" x 17" prints.
 - 2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of Section 23 09 23 Article 3.17 (Control System Demonstration and Acceptance).
 - 3. Operation and Maintenance (O&M) Manual.
 - 4. As-built versions of submittal product data.
 - 5. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
 - 6. Operator's manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
 - 7. Operation and Maintenance (O & M) Manual. This shall include as-built versions of the submittal product data. In addition to the information required for submittals, the O & M Manual shall include:
 - a. Names, addresses, and 24-hour telephone numbers of contractors installing equipment and the control systems, and the service representatives of each.
 - b. Operator's manual with procedures for operating the control systems, including logging on and off, alarm handling, producing point reports, trending data, overriding computer control, and changing set points and other variables.
 - c. One set of programming manuals with a description of the programming language (including syntax), statement descriptions (including algorithms and calculations used), point database creation and modification, program creation and modification, and use of the editor.
 - d. Engineering, installation, and maintenance manual(s) that explain how to design and install new points, panels, and other hardware; preventive maintenance and calibration procedures; how to debug hardware problems; and how to repair or replace hardware.
 - e. A listing and documentation of all custom software created using the programming language, including the set points, tuning parameters, and object database. One set of magnetic or optical media containing files of the software and database shall also be provided.
 - f. One set of magnetic or optical media containing files of all color graphic screens created for the project.
 - g. A list of recommended spare parts with part numbers and suppliers.
 - h. Complete original issue documentation, installation, and maintenance information for all third-party hardware provided, including computer equipment and sensors.
 - i. Complete original issue diskettes for all software provided, including operating systems, programming language, operator workstation software, and graphics software.
 - j. Licenses, guarantees, and warranty documents for all equipment and systems.
 - k. Recommended preventive maintenance procedures for all system components, including a schedule of tasks (inspection, cleaning, calibration), time between tasks, and task descriptions.
 - 8. Programming manual or set of 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.

9. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
 10. Documentation of programs created using custom programming language including setpoints, tuning parameters, and object database. Electronic copies of programs shall meet this requirement if control logic, setpoints, tuning parameters, and objects can be viewed using furnished programming tools.
 11. Graphic files, programs, and database on magnetic or optical media.
 12. List of recommended spare parts with part numbers and suppliers.
 13. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
 14. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation or web server software, and graphics software.
 15. Licenses, guarantees, and warranty documents for equipment and systems.
 16. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
- D. Training Materials: Provide course outline and materials for each class at least six weeks before first class. Training shall be furnished via instructor-led sessions, computer-based training, or web-based training. Engineer will modify course outlines and materials if necessary to meet Owner's needs. Engineer will review and approve course outlines and materials at least three weeks before first class.

1.8 Warranty

- A. Warrant work as follows:
1. Warrant labor and materials for specified control system free from defects for a period of 12 months after final acceptance. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner's warranty service request.
 2. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.
 3. If the engineer determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, the engineer will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.
 4. Provide updates to operator workstation or web server software, project-specific software, graphic software, database software, and firmware that resolve the contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.
 5. Exception: Contractor shall not be required to warrant reused devices except those that have been rebuilt or repaired. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Engineer's acceptance.
- B. Service all work as follows: Provide warranty service in accordance with the warranty section of this Specification. In addition, provide scheduled maintenance on all control system apparatus, including valves, dampers, linkages, control panels, interfaces, direct digital control systems, OWSs, PCs, software, and application programs. Maintenance shall consist of:
1. Scheduled preventive maintenance (p.m.) visit twice a year to audit system performance. Each p.m. visit shall include exercising each control loop and control sequence for performance. A log of each loop tested and each control sequence verified shall be reviewed with the Owner.

2. Provide emergency service for parts and labor on an as-needed basis. Response to an emergency call shall be four hours maximum on Monday-Friday and eight hours maximum on holidays and weekends.
3. Provide remote-service diagnostic monitoring from the nearest service location. At the request of the Owner, a service diagnostic call will be made to troubleshoot and resolve (if possible) any reported system complaints. The Owner will provide a dedicated telephone line or Internet connection to the system.
4. Contractor shall have the ability to provide verification of completed work order or preventive maintenance within one hour of the completion of that service or maintenance action. A paperless version is preferred and may be required.
5. Contractor shall have the ability to receive service requests via an Internet web site or a centralized call center. E-mail requests are not acceptable.
6. Contractor shall have the ability to digitally capture customer signature for authorization of work and work completed; that signature is digitally recorded for verification reasons but will not be used again for any other purpose.

1.9 Ownership of Proprietary Material

- A. Project-specific software and documentation shall become Owner's property. This includes, but is not limited to:
 1. Graphics
 2. Record drawings
 3. Database
 4. Application programming code
 5. Documentation

1.10 Definitions

Term	Definition
BACnet Interoperability Building Blocks (BIBB)	A 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 in a specification.
BACnet/BACnet Standard	BACnet communication requirements as defined by the latest version of ASHRAE/ANSI 135 and approved addenda.
Control Systems Server	A computer(s) that maintain(s) the systems configuration and programming database.
Controller	Intelligent stand-alone control device. Controller is a generic reference to building controllers, custom application controllers, and application specific controllers.
Direct Digital Control	Microprocessor-based control including Analog/Digital conversion and program logic.
Gateway	Bi-directional protocol translator connecting control systems that use different communication protocols.
Local Area Network	Computer or control system communications network limited to local building or campus.
Master-Slave/Token Passing	Data link protocol as defined by the BACnet standard.
Point-to-Point	Serial communication as defined in the BACnet standard.
Primary Controlling LAN	High speed, peer-to-peer controller LAN connecting BCs and optionally AACs and ASCs. Refer to System Architecture below.

Term	Definition
Protocol Implementation Conformance Statement	A written document that identifies the particular options specified by BACnet that are implemented in a device.
Router	A device that connects two or more networks at the network layer.
Wiring	Raceway, fittings, wire, boxes and related items.

PART 2: PRODUCTS

- 2.0 Section Includes
- 2.1 Materials
- 2.2 Communication
- 2.3 Operator Interface
- 2.4 Controller Software
- 2.5 Controllers
- 2.6 Input and Output Interfaces
- 2.7 Power Supplies and Line Filtering
- 2.8 Auxiliary Control Devices
- 2.9 Wiring and Raceways
- 2.10 Fiber Optic Cable System
- 2.11 Compressed Air Supply - Pneumatic

2.1 Materials

- A. Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts shall be available for at least five years after completion of this contract.

2.2 Communication

- A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.
- B. Install new wiring and network devices as required to provide a complete and workable control network.
- C. Use existing Ethernet backbone for network segments marked "existing" on project drawings.
- D. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
- E. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
 - 1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
 - 2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified in Section 23 09 93. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.
- F. Workstations, Building Control Panels, and Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. The system shall automatically adjust for daylight saving and standard time as applicable.
- G. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.

2.3 Operator Interface

- A. The Operator Workstation or server shall conform to the BACnet Operator Workstation (B-OWS) or BACnet Advanced Workstation (B-AWS) device profile as specified in ASHRAE/ANSI 135 BACnet Annex L.
- B. Operator Interface. Web server shall reside on high-speed network with building controllers. Each standard browser connected to server shall be able to access all system information.

- C. Communication. Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135, BACnet Annex J.
- D. Hardware. Each workstation or web server shall consist of the following:
 - 1. Computer. Industry-standard hardware shall meet or exceed DDC system manufacturer's recommended specifications and shall meet response times specified elsewhere in this document. The following hardware requirements also apply:
 - a. The hard disk shall have sufficient memory to store:
 - i. All required operator workstation software.
 - ii. A DDC database at least twice the size of the delivered system database.
 - iii. One year of trend data based on the points specified to be trended at their specified trend intervals.
 - b. Provide additional hardware (communication ports, video drivers, network interface cards, cabling, etc.) to facilitate all control functions and software requirements specified for the DDC system.
 - c. Minimum hardware configuration shall include the following:
 - i. Dual or Quad Core Processor
 - ii. 6 GB RAM
 - iii. 500 GB hard disk providing data at 3.0 Gb/sec
 - iv. 16x DVD-RW drive
 - v. Serial, parallel, and network communication ports and cables as required for proper DDC system operation
- E. System Software.
 - 1. Operating System. Web server or workstation shall have an industry-standard professional-grade operating system. Operating system shall meet or exceed the DDC System manufacturers minimum requirements for their software. Typically acceptable systems include Microsoft Windows7, Microsoft Vista, Microsoft Windows XP Pro, Windows Server 2003 or 2008, Red Hat Enterprise Linux, or Ubuntu Desktop 10.04.
 - 2. System Graphics. The operator interface software shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract.
 - a. Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.
 - b. Animation. Graphics shall be able to animate by displaying different image files for changed object status.
 - c. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
 - d. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Adobe Flash).
 - 3. Custom Graphics. Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system that uses the mouse to create and modify graphics that are saved in the same formats as are used for system graphics.
 - 4. Graphics Library. Furnish a complete library of standard HVAC equipment graphics such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.

- F. System Applications. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard IBM-compatible PCs with no limit on the number of copies that can be installed under the system license.
1. Automatic System Database Configuration. Each workstation or web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
 2. Manual Controller Memory Download. Operators shall be able to download memory from the system database to each controller.
 3. System Configuration. The workstation software shall provide a method of configuring the system. This shall allow for future system changes or additions by users under proper password protection. Operators shall be able to configure the system.
 4. On-Line Help. Provide a context-sensitive, on-line help system to assist the operator in operating and editing the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
 5. Security. Each operator shall be required to log on to the system with user name and password in order to view, edit, add, or delete data.
 - a. Operator Access. The user name and password combination shall define accessible viewing, editing, adding, and deleting privileges for that operator. Users with system administrator rights shall be able to create new users and edit the privileges of all existing users.
 - b. Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. This auto logoff time shall be user adjustable.
 - c. Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.
 6. System Diagnostics. The system shall automatically monitor the operation of all building management panels and controllers. The failure of any device shall be annunciated to the operator.
 7. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in Section 23 09 93 (Sequences of Operation). Alarms shall be BACnet alarm objects and shall use BACnet alarm services.
 8. Alarm Messages. Alarm messages shall use the English language descriptor for the object in alarm in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying on acronyms.
 9. Alarm Reactions. Operator shall be able to configure (by object) what, if any actions are to be taken during an alarm. As a minimum, the workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.
 10. Alarm and Event log. Operators shall be able to view all system alarms and changes of state from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and delete alarms, and archive closed alarms to the workstation or web server hard disk.
 11. Trend Logs. The operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as specified in Section 23 09 93 (Sequences of Operation). Trends shall be BACnet trend objects.
 12. Object and Property Status and Control. Provide a method for the operator to view, and edit if applicable, the status of any object or property in the system. The status shall be available by menu, on graphics, or through custom programs.

13. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
 14. Standard Reports. Furnish the following standard system reports:
 - a. Objects. System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.
 - b. Alarm Summary. Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.
 - c. Logs. System shall log the following to a database or text file and shall retain data for an adjustable period:
 - i. Alarm History.
 - ii. Trend Data. Operator shall be able to select trends to be logged.
 - iii. Operator Activity. At a minimum, system shall log operator log in and log out, control parameter changes, schedule changes, and alarm acknowledgment and deletion. System shall date and time stamp logged activity.
 15. Environmental Index. System shall monitor all occupied zones and compile an index that provides a numerical indication of the environmental comfort within the zone. As a minimum, this indication shall be based upon the deviation of the zone temperature from the heating or cooling setpoint. If humidity is being measured within the zone then the environmental index shall be adjusted to reflect a lower comfort level for high or low humidity levels. Similarly, if carbon dioxide levels are being measured as an indication of ventilation effectiveness then the environmental index shall be adjusted to indicate degraded comfort at high carbon dioxide levels. Other adjustments may be made to the environmental index based upon additional measurements. The system shall maintain a trend of the environmental index for each zone in the trend log. The system shall also compute an average comfort index for every building included in this contract and maintain trendlogs of these building environmental indices. Similarly, the system shall compute the percentage of occupied time that comfortable conditions were maintained within the zones. Through the UI the user shall be able to add a weighting factor to adjust the contribution of each zone to the average index based upon the floor area of the zone, importance of the zone, or other static criteria.
- G. Workstation Application Editors. Each PC or browser workstation shall support editing of all system applications. The applications shall be downloaded and executed at one or more of the controller panels.
1. Controller. Provide a full-screen editor for each type of application that shall allow the operator to view and change the configuration, name, control parameters, and set points for all controllers.
 2. Scheduling. An editor for the scheduling application shall be provided at each workstation. Provide a method of selecting the desired schedule and schedule type. Exception schedules and holidays shall be shown clearly on the calendar. The start and stop times for each object shall be adjustable from this interface.
 3. Custom Application Programming. Provide the tools to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language shall have the following features:
 - a. Language. Language shall be graphically based or English language oriented. If graphically based, language shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and operators shall be able to create custom or compound function blocks. If English language oriented, language shall be based on the syntax of BASIC, FORTRAN, C, or PASCAL, and shall allow for free-form programming that is not column-oriented or "fill-in-the-blanks."
 - b. A full-screen character editor programming environment shall be provided. The editor shall be cursor/mouse-driven and allow the user to insert, add, modify, and delete custom programming code. It also shall incorporate features such as cut/paste and find.

- c. The programming language shall allow independently executing program modules to be developed. Each module shall be able to independently enable and disable other modules.
 - d. The editor/programming environment shall have a debugging/simulation capability that allows the user to step through the program and observe any intermediate values and/or results.
 - e. The programming language shall support conditional statements (IF/THEN/ELSE/ELSE-IF) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
 - f. The programming language shall support floating-point arithmetic using the following operators: +, -, ×, and square root. The following mathematical functions also shall be provided: absolute value and minimum/maximum value.
 - g. The programming language shall have predefined variables that represent time of day, day of the week, month of the year, and the date. Other predefined variables shall provide elapsed time in seconds, minutes, hours, and days. These elapsed time variables shall be able to be reset by the language so that interval-timing functions can be stopped and started within a program. Values from all of the above variables shall be readable by the language so that they can be used in a program for such purposes as IF/ THEN comparisons, calculations, etc.
 - h. The language shall be able to read the values of the variables and use them in programming statement logic, comparisons, and calculations.
 - i. The programming language shall have predefined variables representing the status and results of the system software and shall be able to enable, disable, and change the setpoints of the system software described below.
- H. Portable Operator's Terminal. Provide all necessary software to configure an IBM-compatible laptop computer for use as a Portable Operator's Terminal. Operator shall be able to connect configured Terminal to the system network or directly to each controller for programming, setting up, and troubleshooting.

2.4 Controller Software

- A. Furnish the following applications for building and energy management. All software application shall reside and operate in the system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.
- B. System Security. See Paragraph 2.3.E.5 (Security) and Paragraph 2.3.E.14.c.iii (Operator Activity).
- C. Scheduling. Provide the capability to execute control functions according to a user created or edited schedule. Each schedule shall provide the following schedule options as a minimum:
 - 1. Weekly Schedule. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
 - 2. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule has executed, the system shall discard and replace the exception schedule with the standard schedule for that day of the week.
 - 3. Holiday Schedules. Provide the capability for the operator to define up to 24 special or holiday schedules. These schedules will be repeated each year. The operator shall be able to define the length of each holiday period.
- D. System Coordination. Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.
- E. Binary Alarms. Each binary object shall have the capability to be configured to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.
- F. Analog Alarms. Each analog object shall have both high and low alarm limits. The operator shall be able to enable or disable these alarms.
- G. Alarm Reporting. The operator shall be able to determine the action to be taken in the event of an alarm. An alarm shall be able to start programs, print, be logged in the event log, generate custom messages, and display on graphics.

- H. Remote Communication. System shall automatically contact operator workstation or server on receipt of critical alarms. If no network connection is available, system shall use a modem connection.
- I. Demand Limiting.
 - 1. The demand-limiting program shall monitor building power consumption from a building power meter (provided by others) which generates pulse signals or a BACnet communications interface. An acceptable alternative is for the system to monitor a watt transducer or current transformer attached to the building feeder lines.
 - 2. When power consumption exceeds adjustable levels, system shall automatically adjust setpoints, de-energize low-priority equipment, and take other programmatic actions to reduce demand as specified in Section 23 09 93 (Sequences of Operation). When demand drops below adjustable levels, system shall restore loads as specified.
- J. Maintenance Management. The system shall be capable of generating maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits. Configure and enable maintenance alarms as specified in 23 09 93 (Sequences of Operation).
- K. Sequencing. Application software shall sequence equipment as specified in Section 23 09 93 (Sequences of Operation).
- L. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs. The calculation interval, PID gains, and other tuning parameters shall be adjustable by a user with the correct security level.
- M. Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.
- N. Energy Calculations.
 - 1. The system shall accumulate and convert instantaneous power (kW) or flow rates (L/s [gpm]) to energy usage data.
 - 2. The system shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.
- O. Anti-Short Cycling. All binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.
- P. On and Off Control with Differential. Provide an algorithm that allows a binary output to be cycled based on a controlled variable and a setpoint. The algorithm shall be direct-acting or reverse-acting.
- Q. Runtime Totalization. Provide software to totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as specified in Section 23 09 93 (Sequence of Operations).

2.5 Controllers

- A. General. Provide an adequate number of Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), Smart Actuators (SA), and Smart Sensors (SS) as required to achieve performance specified in Section 23 09 23 Article 1.9 (System Performance). Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of BACnet Smart Actuators and Smart Sensors.
- B. BACnet.
 - 1. Building Controllers (BCs). Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L, and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.
 - 2. Advanced Application Controllers (AACs). Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.
 - 3. Application Specific Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex

- L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.
4. Smart Sensors (SSs). Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-SS in the BACnet Testing Laboratories (BTL) Product Listing.
 5. BACnet Communication.
 - a. Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.
 - b. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
 - c. Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
 - d. Each ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
 - e. Each SA shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
 - f. Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using ARCNET or MS/TP Data Link/Physical layer protocol.
- C. Communication
1. Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
 2. Signal Management. BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
 3. Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.
 4. Stand-Alone Operation. Each piece of equipment specified in Section 23 09 93 shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network such as outdoor air conditions, supply air or water temperature coming from source equipment, etc.
- D. Environment. Controller hardware shall be suitable for anticipated ambient conditions.
1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
 2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).
- E. Keypad. Provide a local keypad and display for each BC and AAC. Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not normally provide a keypad and display for each BC and AAC, provide the software and any interface cabling needed to use a laptop computer as a Portable Operator's Terminal for the system.
- F. Real-Time Clock. Controllers that perform scheduling shall have a real-time clock.
- G. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to a field-removable modular terminal strip or to a termination card connected by a ribbon cable. Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.
- H. Memory.
1. Controller memory shall support operating system, database, and programming requirements.
 2. Each BC and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.

3. Each ASC and SA shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.
- I. Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
- J. Transformer. ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.

2.6 Input and Output Interface

- A. General. Hard-wire input and output points to BCs, AACs, ASCs, or SAs.
- B. Protection. All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground shall cause no damage to the controller. All input and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no controller damage.
- C. Binary Inputs. Binary inputs shall allow the monitoring of ON/OFF signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.
- D. Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall also accumulate up to 10 pulses per second.
- E. Analog Inputs. Analog inputs shall monitor low-voltage (0–10 Vdc), current (4–20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
- F. Binary Outputs. Binary outputs shall provide for ON/OFF operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on Building Controllers shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.
- G. Analog Outputs. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0–10 Vdc or a 4–20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.
- H. Tri-State Outputs. Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.
- I. System Object Capacity. The system size shall be expandable to at least twice the number of input/output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system

2.7 Power Supplies and Line Filtering

- A. Power Supplies. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
 1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.
 - a. Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
 - b. Line voltage units shall be UL recognized and CSA listed.
- B. Power Line Filtering.

1. Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have:
 - a. Dielectric strength of 1000 V minimum
 - b. Response time of 10 nanoseconds or less
 - c. Transverse mode noise attenuation of 65 dB or greater
 - d. Common mode noise attenuation of 150 dB or greater at 40–100 Hz

2.8 Auxiliary Control Devices

A. Electric Damper and Valve Actuators.

1. Stall Protection. Mechanical or electronic stall protection shall prevent actuator damage throughout the actuator's rotation.
2. Spring-return Mechanism. Actuators used for power-failure and safety applications shall have an internal mechanical spring-return mechanism or an uninterruptible power supply (UPS).
3. Signal and Range. Proportional actuators shall accept a 0–10 Vdc or a 0–20 mA control signal and shall have a 2–10 Vdc or 4–20 mA operating range. (Floating motor actuators may be substituted for proportional actuators in terminal unit applications as described in paragraph 2.6H.)
4. Wiring. 24 Vac and 24 Vdc actuators shall operate on Class 2 wiring.
5. Manual Positioning. Operators shall be able to manually position each actuator when the actuator is not powered. Non-spring-return actuators shall have an external manual gear release. Spring-return actuators with more than 7 N·m (60 in.-lb) torque capacity shall have a manual crank.

B. Control Valves.

1. Control valves shall be two-way type for two-position or modulating service as shown.
2. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
 - a. Water Valves:
 - i. Two-way: 150% of total system (pump) head.
3. Water Valves.
 - a. Body and trim style and materials shall be in accordance with manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.
 - b. Sizing Criteria:
 - i. Two-position service: Line size.
 - ii. Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 5 psi, whichever is greater.
 - iii. Valves ½ in. through 2 in. shall be bronze body or cast brass ANSI Class 250, spring-loaded, PTFE packing, quick opening for two-position service. Two-way valves to have replaceable composition disc or stainless steel ball.
 - iv. Valves 2½ in. and larger shall be cast iron ANSI Class 125 with guided plug and PTFE packing.
 - c. Water valves shall fail normally open or closed, as scheduled on plans, or as follows:
 - i. Water zone valves—normally open preferred.
 - ii. Heating coils in air handlers—normally open.
 - iii. Chilled water control valves—normally closed.
 - iv. Other applications—as scheduled or as required by sequences of operation.

C. Binary Temperature Devices.

1. Low-Voltage Space Thermostats. Low-voltage space thermostats shall be 24 V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C–30°C (55°F–85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover. Thermostats shall be equipped with user-adjustable controls capable of relative setpoint adjustment from 65°F to 75°F. The thermostats shall be equipped with an occupancy override, and shall be capable of

interfacing with a BACNet control system. Sensor accuracy shall be +/- 0.1 °F or better in the range of 65°F to 75°F.

2. Line-Voltage Space Thermostats. Line-voltage space thermostats shall be bimetal-actuated, open-contact type or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listing for electrical rating, concealed setpoint adjustment, 13°C–30°C (55°F–85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.
3. Low-Limit Thermostats. Low-limit airstream thermostats shall be UL listed, vapor pressure type. Element shall be at least 6 m (20 ft) long. Element shall sense temperature in each 30 cm (1 ft) section and shall respond to lowest sensed temperature. Low-limit thermostat shall be manual reset only.

D. Temperature Sensors.

1. Type. Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor.
2. Duct Sensors. Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 1.5 m (5 ft) in length per 1 m² (10 ft²) of duct cross-section.
3. Immersion Sensors. Provide immersion sensors with a separable stainless steel well. Well pressure rating shall be consistent with system pressure it will be immersed in. Well shall withstand pipe design flow velocities.
4. Space Sensors. Space sensors shall have setpoint adjustment, override switch, display, and communication port as shown.
5. Differential Sensors. Provide matched sensors for differential temperature measurement.

E. HUMIDITY TRANSMITTERS

1. Units shall be suitable for duct, wall (room) or outdoor mounting. Unit shall be two-wire transmitter utilizing bulk polymer resistance change or thin film capacitance change humidity sensor. Unit shall produce linear continuous output of 4-20 mA for percent relative humidity (% RH). A combination temperature and humidity sensor may be used for zone level monitoring. Sensors shall have the following minimum performance and application criteria:
 - a. Input Range: 0 to 100% RH.
 - b. Accuracy (% RH): +/- 2% (when used for room, outside air and duct measurements) between 20-90% RH at 77°F, including hysteresis, linearity, and repeatability.
 - c. Accuracy (% RH): +/- 1% (when used for critical measurements museum and chilled beam) between 20-90% RH at 77°F, including hysteresis, linearity, and repeatability.
 - d. Sensor Operating Range: As required by application.
 - e. Long Term Stability: Less than 1% drift per year.
2. Acceptable Manufacturers: Units shall be Vaisala or Veris. Substitutions shall be allowed with prior written permission from PU Controls Engineer.

F. CO₂ Carbon dioxide sensors:

1. Sensing of carbon dioxide shall incorporate the NDIR—non-dispersive infrared—sensing method. The sensor shall incorporate sampling tubes for duct mounting and have optional LCD readout. Range of sensing shall be 0-2000 PPM and field adjustable 0-1000 PPM, 0-2000PPM, 500-1500PPM, and 500-2000PPM, with an accuracy of ± 75 PPM from 0 to 2000 PPM and ± 5 percent above 1500 PPM. Annual drift shall be (20PPM nominal) and have a calibration interval of five years recommended. Output shall be 4-20 ma and have an operating temperature range of +32 to +122 degrees F and 0 to 95 percent RH, non-condensing.

G. Relays.

1. Control Relays. Control relays shall be plug-in type, UL listed, and shall have dust cover and LED “energized” indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
2. Time Delay Relays. Time delay relays shall be solid-state plug-in type, UL listed, and shall have adjustable time delay. Delay shall be adjustable ±100% from setpoint shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.

H. Override Timers.

1. Unless implemented in control software, override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration required by application. Provide 0–6 hour calibrated dial unless otherwise specified. Flush mount timer on local control panel face or where shown.
- I. Current Transmitters.
 1. AC current transmitters shall be self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4–20 mA two-wire output. Full-scale unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment. Unit accuracy shall be $\pm 1\%$ full-scale at 500 ohm maximum burden.
 2. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.
 3. Unit shall be split-core type for clamp-on installation on existing wiring.
- J. Current Transformers.
 1. AC current transformers shall be UL/CSA recognized and shall be completely encased (except for terminals) in approved plastic material.
 2. Transformers shall be available in various current ratios and shall be selected for $\pm 1\%$ accuracy at 5 A full-scale output.
 3. Use fixed-core transformers for new wiring installation and split-core transformers for existing wiring installation.
- K. Voltage Transmitters.
 1. AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4–20 mA output with zero and span adjustment.
 2. Adjustable full-scale unit ranges shall be 100–130 Vac, 200–250 Vac, 250–330 Vac, and 400–600 Vac. Unit accuracy shall be $\pm 1\%$ full-scale at 500 ohm maximum burden.
 3. Transmitters shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized at 600 Vac rating.
- L. Voltage Transformers.
 1. AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.
 2. Transformers shall be suitable for ambient temperatures of 4°C–55°C (40°F–130°F) and shall provide $\pm 0.5\%$ accuracy at 24 Vac and 5 VA load.
 3. Windings (except for terminals) shall be completely enclosed with metal or plastic.
- M. Power Monitors.
 1. Selectable rate pulse output for kWh reading, 4–20 mA output for kW reading, N.O. alarm contact, and ability to operate with 5.0 amp current inputs or 0–0.33 volt inputs.
 2. 1.0% full-scale true RMS power accuracy, ± 0.5 Hz, voltage input range 120–600 V, and auto range select.
 3. Under voltage/phase monitor circuitry.
 4. NEMA 1 enclosure.
 5. Current transformers having a 0.5% FS accuracy, 600 VAC isolation voltage with 0–0.33 V output. If 0–5 A current transformers are provided, a three-phase disconnect/shorting switch assembly is required.
- N. Thermal Energy Meters
 1. Matched RTD, solid state, or thermistor temperature sensors with a differential temperature accuracy of $\pm 0.15^\circ\text{F}$.
 2. Flow meter : See "Hydronic Flowmeters" section.
 3. Unit accuracy of $\pm 1\%$ factory calibrated, traceable to NIST with certification.
 4. NEMA 1 enclosure.
 5. Panel mounted display.
 6. UL listed.
 7. Isolated 4–20 ma signals for energy rate and supply and return temperatures and flow.
- O. Current Switches.
 1. Current-operated switches shall be self-powered, solid-state with adjustable trip current. Select switches to match application current and DDC system output requirements.
- P. Pressure Transducers.
 1. Transducers shall have linear output signal and field-adjustable zero and span.

2. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage.
 3. Water pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi). Transducer shall have 4–20 mA output, suitable mounting provisions, and block and bleed valves.
 4. Water differential pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi). Over-range limit (differential pressure) and maximum static pressure shall be 2000 kPa (300 psi.) Transducer shall have 4–20 mA output, suitable mounting provisions, and 5-valve manifold.
- Q. Differential Pressure Switches. Differential pressure switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum) and shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.
- R. Pressure-Electric (PE) Switches.
1. Shall be metal or neoprene diaphragm actuated, operating pressure rated for 0–175 kPa (0–25 psig), with calibrated scale minimum setpoint range of 14–125 kPa (2–18 psig) minimum, UL listed.
 2. Provide one- or two-stage switch action (SPDT, DPST, or DPDT) as required by application. Electrically rated for pilot duty service (125 VA minimum) and/or for motor control.
 3. Switches shall be open type (panel-mounted) or enclosed type for remote installation. Enclosed type shall be NEMA 1 unless otherwise specified.
 4. Each pneumatic signal line to PE switches shall have permanent indicating gauge.
- S. Occupancy Sensors. Occupancy sensors shall utilize Passive Infrared (PIR) and/or Microphonic Passive technology to detect the presence of people within a room. Sensors shall be mounted as indicated on the approved drawings. The sensor output shall be accessible by any lighting and/or HVAC controller in the system. Occupancy sensors shall be capable of being powered from the lighting or HVAC control panel, as shown on the drawings. Occupancy sensor delay shall be software adjustable through the user interface and shall not require manual adjustment at the sensor.
- T. Local Control Panels.
1. All indoor control cabinets shall be fully enclosed NEMA 1 construction with (hinged door) key-lock latch and removable subpanels. A single key shall be common to all field panels and subpanels.
 2. Interconnections between internal and face-mounted devices shall be prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600 volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
 3. Provide ON/OFF power switch with overcurrent protection for control power sources to each local panel.

2.9 Wiring and Raceways

- A. General. Provide copper wiring, plenum cable, and raceways as specified in applicable sections of Division 26.
- B. Insulated wire shall use copper conductors and shall be UL listed for 90°C (200°F) minimum service.

2.10 Fiber Optic Cable System

- A. Optical Cable. Optical cables shall be duplex 900 mm tight-buffer construction designed for intra-building environments. Sheath shall be UL listed OFNP in accordance with NEC Article 770. Optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125mm.
- B. Connectors. Field terminate optical fibers with ST type connectors. Connectors shall have ceramic ferrules and metal bayonet latching bodies.

PART 3: EXECUTION

- 3.0 Section Includes
- 3.1 Examination
- 3.2 Protection
- 3.3 Coordination
- 3.4 General Workmanship
- 3.5 Field Quality Control
- 3.6 Existing Equipment
- 3.7 Wiring
- 3.8 Communication Wiring
- 3.9 Fiber Optic Cable
- 3.10 Control Air Tubing
- 3.11 Installation of Sensors
- 3.12 Flow Switch Installation
- 3.13 Actuators
- 3.14 Warning Labels
- 3.15 Identification of Hardware and Wiring
- 3.16 Controllers
- 3.17 Programming
- 3.18 Control system Checkout and Testing
- 3.19 Control System Demonstration and Acceptance
- 3.20 Cleaning
- 3.21 Training
- 3.22 Sequences of Operation
- 3.23 Control Valve Installation
- 3.24 Control Damper Installation
- 3.25 Smoke Damper Installation
- 3.26 Duct Smoke Detection
- 3.27 Controls Communication Protocol

3.1 Start-Up and Checkout ProceduresExamination

- A. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.
- B. The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate—or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others—the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the contractor to report such discrepancies shall be made by—and at the expense of—this contractor.

3.2 Protection

- A. The contractor shall protect all work and material from damage by his/her work or employees and shall be liable for all damage thus caused.
- B. The contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The contractor shall protect any material that is not immediately installed. The contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.3 Coordination

- A. Site

1. Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment. If the contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, the contractor shall make the necessary changes in his/her work to correct the condition without extra charge.
 2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.
- B. Submittals. See Section 23 09 23 Article 1.10 (Submittals).
- C. Test and Balance.
1. The contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
 2. The contractor shall provide training in the use of these tools. This training will be planned for a minimum of 4 hours.
 3. In addition, the contractor shall provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.
 4. The tools used during the test and balance process will be returned at the completion of the testing and balancing.
- D. Life Safety.
1. Duct smoke detectors required for air handler shutdown are provided under Division 28. Interlock smoke detectors to air handlers for shutdown as specified in Section 23 09 93 (Sequences of Operation).
 2. Smoke dampers and actuators required for duct smoke isolation are provided under Division 23. Interlock smoke dampers to air handlers as specified in Section 23 09 93 (Sequences of Operation).
 3. Fire and smoke dampers and actuators required for fire-rated walls are provided under Division 23. Fire and smoke damper control is provided under Division 28.
- E. Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the contractor as follows:
1. All communication media and equipment shall be provided as specified in Section 23 09 23 Article 2.2 (Communication).
 2. Each supplier of a controls product is responsible for the configuration, programming, start up, and testing of that product to meet the sequences of operation described in Section 23 09 93.
 3. The contractor shall coordinate and resolve any incompatibility issues that arise between control products provided under this section and those provided under other sections or divisions of this specification.
 4. The contractor is responsible for providing all controls described in the contract documents regardless of where within the contract documents these controls are described.
 5. The contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the contract documents.

3.4 General Workmanship

- A. Install equipment, piping, and wiring/raceway parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.
- B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- C. Install equipment in readily accessible locations as defined by Chapter 1 Article 100 Part A of the National Electrical Code (NEC).
- D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- E. All equipment, installation, and wiring shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.5 Field Quality Control

- A. All work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances as identified in Section 23 09 23 Article 1.8 (Codes and Standards).
- B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship.
- C. Contractor shall have work inspection by local and/or state authorities having jurisdiction over the work.

3.6 Existing Equipment

- A. Campus BAS. The existing system shall remain and be tied into with new building BAS.

3.7 Wiring

- A. All control and interlock wiring shall comply with national and local electrical codes, and Division 26 of this specification, Where the requirements of this section differ from Division 26, the requirements of this section shall take precedence.
- B. All NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway according to NEC and Division 26 requirements.
- C. All low-voltage wiring shall meet NEC Class 2 requirements. Low-voltage power circuits shall be subfused when required to meet Class 2 current limit.
- D. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL listed for the intended application.
- E. All wiring in mechanical, electrical, or service rooms – or where subject to mechanical damage – shall be installed in raceway at levels below 3 m (10ft).
- F. Do not install Class 2 wiring in raceways containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).
- G. Do not install wiring in raceway containing tubing.
- H. Where Class 2 wiring is run exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 3 m (10 ft) intervals.
- I. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.
- J. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.
- K. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- L. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the contractor shall provide step-down transformers.
- M. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
- N. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.
- O. Size of raceway and size and type of wire type shall be the responsibility of the contractor in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.
- P. Include one pull string in each raceway 2.5 cm (1 in.) or larger.
- Q. Use color-coded conductors throughout with conductors of different colors.
- R. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.
- S. Conceal all raceways except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 15 cm (6 in.) from high-temperature equipment (e.g. steam pipes or flues).
- T. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.

- U. Adhere to this specification's Division 26 requirements where raceway crosses building expansion joints.
- V. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of vertical raceways.
- W. The contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- X. Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Flexible metal raceway less than ½ in. electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.
- Y. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

3.8 Communication Wiring

- A. The contractor shall adhere to the items listed in the "Wiring" article in Part 3 of the specification.
- B. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling
- C. Do not install communication wiring in raceways and enclosures containing Class 1 or other Class 2 wiring.
- D. Maximum pulling, tension, and bend radius for the cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.
- E. Contractor shall verify the integrity of the entire network following cable installation. Use appropriate test measures for each particular cable.
- F. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to manufacturer's instructions.
- G. All runs of communication wiring shall be unspliced length when that length is commercially available.
- H. All communication wiring shall be labeled to indicate origination and destination data.
- I. All communication wiring shall be labeled to indicate origination and destination data.
- J. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."
- K. BACnet MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:
 - 1. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot.)
 - 2. The maximum length of an MS/TP segment is 1200 meters (4000 ft) with AWG 18 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.
 - 3. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
 - 4. An MS/TP EIA-485 network shall have no T connections.

3.9 Fiber Optic Cable

- A. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post-installation residual cable tension shall be within cable manufacturer's specifications.
- B. All cabling and associated components shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii, as specified by cable manufacturer, shall be maintained.

3.10 Installation of Sensors

- A. Install sensors in accordance with the manufacturer's recommendations.
- B. Mount sensors rigidly and adequately for environment within which the sensor operates.

- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by wall framing.
- D. All wires attached to sensors shall be sealed in their raceways or in the wall to stop air transmitted from other areas from affecting sensor readings.
- E. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
- F. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 3 m (1 ft) of sensing element for each 1 m²(1 ft²) of coil area.
- G. Do not install temperature sensors within the vapor plume of a humidifier. If installing a sensor downstream of a humidifier, install it at least 3 m (10 ft) downstream.
- H. All pipe-mounted temperature sensors shall be installed in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.
- I. Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.
- J. Differential Air Static Pressure.
 - 1. Supply Duct Static Pressure. Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the height-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.
 - 2. Return Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor.
 - 3. Building Static Pressure. Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover.
 - 4. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
 - 5. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.
 - 6. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shut-off valves installed before the tee.
- K. Smoke detectors, freezestats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.
- L. Install humidity sensors for duct mounted humidifiers at least 3 m (10 ft) downstream of the humidifier. Do not install filters between the humidifier and the sensor.

3.11 Flow Switch Installation

- A. Use correct paddle for pipe diameter.
- B. Adjust flow switch according to manufacturer's instructions.

3.12 Actuators

- A. General. Mount and link control damper actuators according to manufacturer's instructions.
 - 1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.
 - 2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
 - 3. Provide all mounting hardware and linkages for actuator installation.
- B. Electric/Electronic
 - 1. Dampers: Actuators shall be direct mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with

a minimum 5° travel available for tightening the damper seal. Actuators shall be mounted following manufacturer's recommendations.

2. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

C. Pneumatic Actuators.

1. Size pneumatic damper actuator to operate the related control damper(s) with sufficient reserve power to provide smooth modulating action or two-position action. Actuator also shall be sized for proper speed of response at the velocity and pressure conditions to which the control damper is subject.
2. Pneumatic damper actuators shall produce sufficient torque to close off against the maximum system pressures encountered. Size the pneumatic damper actuator to close off against the fan shutoff pressure, as a minimum.
3. Where two or more pneumatic damper actuators are installed for interrelated operation in unison, such as dampers used for mixing, provide the dampers with a positive pilot positioner. The positive pilot positioner shall be directly mounted to the pneumatic damper actuator and have pressure gauges for supply input and output pressures.
4. The total damper area operated by an actuator shall not exceed 80% of the manufacturer's maximum area rating. Provide at least one actuator for each damper section. Each damper actuator shall not power more than 2 m²(20 ft²) of damper.
5. Use line shafting or shaft couplings (jackshafting) in lieu of blade-to-blade linkages or shaft coupling when driving axially aligned damper sections.

3.13 Warning Labels

- A. Permanent warning labels shall be affixed to all equipment that can be automatically started by the control system.
1. Labels shall use white lettering (12-point type or larger) on a red background.
 2. Warning labels shall read as follows.

C A U T I O N

This equipment is operating under automatic control and may start or stop at any time without warning.
Switch disconnect to "Off" position before servicing.

- B. Permanent warning labels shall be affixed to all motor starters and control panels that are connected to multiple power sources utilizing separate disconnects.
1. Labels shall use white lettering (12-point type or larger) on a red background.
 2. Warning labels shall read as follows.

C A U T I O N

This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

3.14 Identification of Hardware and Wiring

- A. All wiring and cabling, including that within factory-fabricated panels shall be labeled at each end within 5 cm (2 in.) of termination with control system address or termination number.
- B. All pneumatic tubing shall be labeled at each end within 5 cm (2 in.) of termination with a descriptive identifier.
- C. Permanently label or code each point of field terminal strips to show the instrument or item served.
- D. Identify control panels with minimum 1 cm (½ in.) letters on laminated plastic nameplates.
- E. Identify all other control components with permanent labels. All plug-in components shall be labeled such that label removal of the component does not remove the label.
- F. Identify room sensors related to terminal boxes or valves with nameplates.
- G. Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.
- H. Identifiers shall match record documents.

3.15 Controllers

- A. Provide a separate controller for each AHU or other HVAC system. A DDC controller may control more than one system provided that all points associated with the system are assigned to the same DDC controller. Points used for control loop reset, such as outside air or space temperature, are exempt from this requirement.
- B. Building Controllers and Custom Application Controllers shall be selected to provide the required I/O point capacity required to monitor all of the hardware points listed in Section 23 09 93 (Sequences of Operation).

3.16 Programming

- A. Provide sufficient internal memory for the specified sequences of operation and trend logging.
- B. Point Naming. Name points as shown on the equipment points list provided with each sequence of operation. See Section 23 09 93 (Sequences of Operation). If character limitations or space restrictions make it advisable to shorten the name, the abbreviations given in Appendix B to Section 23 09 93 may be used. Where multiple points with the same name reside in the same controller, each point name may be customized with its associated Program Object number. For example, "Zone Temp 1" for Zone 1, "Zone Temp 2" for Zone 2.
- C. Software Programming.
 - 1. Provide programming for the system and adhere to the sequences of operation provided. All other system programming necessary for the operation of the system, but not specified in this document, also shall be provided by the contractor. Embed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Use the appropriate technique based on the following programming types:
 - a. Text-based:
 - i. Must provide actions for all possible situations
 - ii. Must be modular and structured
 - iii. Must be commented
 - b. Graphic-based:
 - i. Must provide actions for all possible situations
 - ii. Must be documented
 - c. Parameter-based:
 - i. Must provide actions for all possible situations
 - ii. Must be documented.
- D. Operator Interface.
 - 1. Standard Graphics. Provide graphics for all mechanical systems and floor plans of the building. This includes each chilled water system, hot water system, chiller, boiler, air handler, and all terminal equipment. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as setpoints. As a minimum, show on each equipment graphic the input and output points and relevant calculated points as indicated on the applicable Points List in Section 23 09 93.
 - 2. The contractor shall provide all the labor necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, and any third-party software installation and integration required for successful operation of the operator interface.

3.17 Control System Checkout and Testing

- A. Startup Testing. All testing listed in this article shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the owner's representative is notified of the system demonstration.
 - 1. The contractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.

2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturers' recommendations.
4. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
5. Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The contractor shall check all control valves and automatic dampers to ensure proper action and closure. The contractor shall make any necessary adjustments to valve stem and damper blade travel.
6. Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops.
7. Alarms and Interlocks:
 - a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
 - b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
 - c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action

3.18 Control System Demonstration and Acceptance

A. Demonstration.

1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.
2. The tests described in this section are to be performed in addition to the tests that the contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the "Control System Checkout and Testing" article in Part 3 of this specification. The engineer will be present to observe and review these tests. The engineer shall be notified at least 10 days in advance of the start of the testing procedures.
3. The demonstration process shall follow that approved in Part 1, "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.
4. The contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.
5. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
6. Demonstrate compliance with Part 1, "System Performance."
7. Demonstrate compliance with sequences of operation through all modes of operation.
8. Demonstrate complete operation of operator interface.
9. Additionally, the following items shall be demonstrated:
 - a. DDC loop response. The contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.
 - b. Demand limiting. The contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-

by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting set point, and the status of sheddable equipment outputs.

- c. Optimum start/stop. The contractor shall supply a trend data output showing the capability of the algorithm. The change-of-value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.
 - d. Interface to the building fire alarm system.
 - e. Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the architect/engineer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.
10. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

B. Acceptance.

- 1. All tests described in this specification shall have been performed to the satisfaction of both the engineer and owner prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the engineer. Such tests shall then be performed as part of the warranty.
- 2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1, "Submittals."

3.19 Cleaning

- A. The contractor shall clean up all debris resulting from his/her activities daily. The contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.
- B. At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.
- C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.20 Training

- A. Provide training for a designated staff of Owner's representatives. Training shall be provided via self-paced training, web-based or computer-based training, classroom training, or a combination of training methods.
- B. Training shall enable students to accomplish the following objectives.
 - 1. Day-to-day Operators:
 - a. Proficiently operate the system
 - b. Understand control system architecture and configuration
 - c. Understand DDC system components
 - d. Understand system operation, including DDC system control and optimizing routines (algorithms)
 - e. Operate the workstation and peripherals
 - f. Log on and off the system
 - g. Access graphics, point reports, and logs
 - h. Adjust and change system set points, time schedules, and holiday schedules
 - i. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
 - j. Understand system drawings and Operation and Maintenance manual
 - k. Understand the job layout and location of control components
 - l. Access data from DDC controllers and ASCs

- m. Operate portable operator's terminals
- 2. Advanced Operators:
 - a. Make and change graphics on the workstation
 - b. Create, delete, and modify alarms, including annunciation and routing of these
 - c. Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable time intervals
 - d. Create, delete, and modify reports
 - e. Add, remove, and modify system's physical points
 - f. Create, modify, and delete programming
 - g. Add panels when required
 - h. Add operator interface stations
 - i. Create, delete, and modify system displays, both graphical and others
 - j. Perform DDC system field checkout procedures
 - k. Perform DDC controller unit operation and maintenance procedures
 - l. Perform workstation and peripheral operation and maintenance procedures
 - m. Perform DDC system diagnostic procedures
 - n. Configure hardware including PC boards, switches, communication, and I/O points
 - o. Maintain, calibrate, troubleshoot, diagnose, and repair hardware
 - p. Adjust, calibrate, and replace system components
- 3. System Managers/Administrators:
 - a. Maintain software and prepare backups
 - b. Interface with job-specific, third-party operator software
 - c. Add new users and understand password security procedures
- C. Organize the training into sessions or modules for the three levels of operators listed above. (Day-to-Day Operators, Advanced Operators, System Managers and Administrators). Students will receive one or more of the training packages, depending on knowledge level required.
- D. Provide course outline and materials according to the "Submittals" article in Part 1 of this specification. Provide one copy of training material per student.
- E. The instructor(s) shall be factory-trained and experienced in presenting this material.
- F. Classroom training shall be done using a network of working controllers representative of installed hardware.

3.21 Sequences of Operation

See Section 23, Appendix A (Sequences of Operation, With Points Lists).

3.22 Control Valve Installation

- A. Valve submittals shall be coordinated for type, quantity, size, and piping configuration to ensure compatibility with pipe design.
- B. Slip-stem control valves shall be installed so that the stem position is not more than 60 degrees from the vertical up position. Ball type control valves shall be installed with the stem in the horizontal position.
- C. Valves shall be installed in accordance with the manufacturer's recommendations.
- D. Control valves shall be installed so that they are accessible and serviceable and so that actuators may be serviced and removed without interference from structure or other pipes and/or equipment.
- E. Isolation valves shall be installed so that the control valve body may be serviced without draining the supply/return side piping system. Unions shall be installed at all connections to screw-type control valves.
- F. Provide tags for all control valves indicating service and number. Tags shall be brass, 1.5 inch in diameter, with ¼ inch high letters. Securely fasten with chain and hook. Match identification numbers as shown on approved controls shop drawings.

3.23 Control Damper Installation

- A. Damper submittals shall be coordinated for type, quantity, and size to ensure compatibility with sheet metal design.

- B. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure ¼ in. larger than damper dimensions and shall be square, straight, and level.
- C. Individual damper sections, as well as entire multiple section assemblies, must be completely square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be within 0.3 cm (1/8 in.) of each other.
- D. Follow the manufacturer's instructions for field installation of control dampers. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.
- E. Install extended shaft or jackshaft according to manufacturer's instructions. (Typically, a sticker on the damper face shows recommended extended shaft location. Attach shaft on labeled side of damper to that blade.)
- F. Damper blades, axles, and linkage must operate without binding. Before system operation, cycle damper after installation to ensure proper operation. On multiple section assemblies, all sections must open and close simultaneously.
- G. Provide a visible and accessible indication of damper position on the drive shaft end.
- H. Support ductwork in area of damper when required to prevent sagging due to damper weight.
- I. After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

3.24 Smoke Damper Installation

- A. The contractor shall coordinate all smoke and smoke/fire damper installation, wiring, and checkout to ensure that these dampers function properly and that they respond to the proper fire alarm system general, zone, and/or detector trips. The contractor shall immediately report any discrepancies to the engineer no less than two weeks prior to inspection by the code authority having jurisdiction.
- B. Provide complete submittal data to controls system subcontractor for coordination of duct smoke detector interface to HVAC systems.

3.25 Duct Smoke Detection

- A. Submit data for coordination of duct smoke detector interface to HVAC systems as required in Part 1, "Submittals."
- B. This Contractor shall provide a dry-contact alarm output in the same room as the HVAC equipment to be controlled.

3.26 Controls Communication Protocol

- A. General. The electronic controls packaged with this equipment shall communicate with the building direct digital control (DDC) system. The DDC system shall communicate with these controls to read the information and change the control setpoints as shown in the points list, sequences of operation, and control schematics. The information to be communicated between the DDC system and these controls shall be in the standard object format as defined in ANSI/ASHRAE Standard 135 (BACnet). Controllers shall communicate with other BACnet objects on the internetwork using the Read (Execute) Property service as defined in Clause 15.5 of Standard 135.
- B. Distributed Processing. The controller shall be capable of stand-alone operation and shall continue to provide control functions if the network connection is lost.
- C. I/O Capacity. The controller shall contain sufficient I/ O capacity to control the target system.
- D. The Controller shall have a physical connection for a laptop computer or a portable operator's tool.
- E. Environment. The hardware shall be suitable for the anticipated ambient conditions.
 - 1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 40°C to 60°C (40°F to 140°F).
 - 2. Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).
- F. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field removable, modular terminal strips or to a termination card connected by a ribbon cable.
- G. Memory. The Controller shall maintain all BIOS and programming information in the event of a power loss for at least 30 days.
- H. Power. Controller shall be able to operate at 90% to 110% of nominal voltage rating.

- I. Transformer. Power supply for the Controller must be rated at minimum of 125% of ASC power consumption and shall be fused or current limiting type.

3.27 Start-Up and Checkout Procedures

- A. Start up, check out, and test all hardware and software and verify communication between all components.
 1. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
 2. Verify that all analog and binary input/output points read properly.
 3. Verify alarms and interlocks.
 4. Verify operation of the integrated system.

APPENDIX A: Glossary of Terms

Terms used within the Specification Text:

- Advanced Application Controller (AAC):

A fully programmable control module. This control module may be capable of some of the advanced features found in Building Controllers (storing trends, initiating read and write requests, etc.) but it does not serve as a master controller. Advanced Application Controllers may reside on either the Ethernet/IP backbone or on a subnet.

- Application Specific Controller (ASC):

A pre-programmed control module which is intended for use in a specific application. ASCs may be configurable, in that the user can choose between various pre-programmed options, but it does not support full custom programming. ASCs are often used on terminal equipment such as VAV boxes or fan coil units. In many vendors' architectures ASCs do not store trends or schedules but instead rely upon a Building Controller to provide those functions.

- BACnet/IP:

An approved BACnet network type which uses an Ethernet carrier and IP addressing.

- BACnet MS/TP:

An approved BACnet network type which uses a Master-Slave Token Passing configuration. MS/TP networks are unique to BACnet and utilize EIA485 twisted pair topology running at 9600 to 76,800 bps.

- BACnet over ARCNET:

An approved BACnet network type which uses an ARCNET (attached resource computer network) carrier. ARCNET is an industry standard that can utilize several speeds and wiring standards. The most common configuration used by BACnet controllers is an EIA485 twisted pair topology running at 156,000 bps.

- Building Controller (BC):

A fully programmable control module which is capable of storing trends and schedules, serving as a router to devices on a subnet, and initiating read and write requests to other controllers. Typically this controller is located on the Ethernet/IP backbone of the BAS. In many vendors' architectures a Building Controller will serve as a master controller, storing schedules and trends for controllers on a subnet underneath the Building Controller.

- Direct Digital Control (DDC):

A control system in which a digital computer or microprocessor is directly connected to the valves, dampers, and

other actuators which control the system, as opposed to indirectly controlling a system by resetting setpoints on an analog pneumatic or electronic controller.

- PICS - Protocol Implementation Conformance Statement:

A written document, created by the manufacturer of a device, which identifies the particular options specified by BACnet that are implemented in the device.

- Smart Actuator (SA):

An actuator which is controlled by a network connection rather than a binary or analog signal. (0-10v, 4-20mA, relay, etc.)

- Smart Sensor (SS):

A sensor which provides information to the BAS via network connection rather than a binary or analog signal. (0-10000 ohm, 4-20mA, dry contact, etc.)

- Web services:

Web services are a standard method of exchanging data between computer systems using the XML (extensible markup language) and SOAP (simple object access protocol) standards. Web services can be used at any level within a Building Automation System (BAS), but most commonly they are used to transfer data between BAS using different protocols or between a BAS and a non-BAS system such as a tenant billing system or a utility management system.

Terms used within the Sequences of Operation:

- adj.

Adjustable by the end user, through the supplied user interface.

- AI, AO, etc. (Column Headings on Points List)

AI = Analog Input. A physical input to the control module.

AO = Analog Output. A physical output from the control module.

AV = Analog Value. An intermediate (software) point that may be editable or read-only. Editable AVs are typically used to allow the user to set a fixed control parameter, such as a setpoint. Read Only AVs are typically used to display the status of a control operation.

BI = Binary Input. A physical input to the control module.

BO = Binary Output. A physical output from the control module.

BV = Binary Value. An intermediate (software) point that may be editable or read-only. Editable BVs are typically used to allow the user to set a fixed control parameter, such as a setpoint. Read Only BVs are typically used to display the status of a control operation.

Loop = A control loop. Most commonly a PID control loop. Typically a control loop will include a setpoint, an input which is compared to the setpoint, and an output which controls some action based upon the difference between the input and the setpoint. A PID control loop will also include gains for the proportional, integral, and derivative response as well as an interval which controls how frequently the control loop updates its output. These gains may be adjustable by the end user for control loop "tuning," but in self-tuning control loops or loops which have been optimized for a specific application the gains may not be adjustable.

Sched = Schedule. The control algorithm for this equipment shall include a user editable schedule.

Trend. The control system shall be configured to collect and display a trend log of this object. The trending interval shall be no less than one sample every 5 minutes. (Change of Value trending, where a sample is taken every time the value changes by more than a user-defined minimum, is an acceptable alternative.)

Alarm. The control system shall be configured to generate an alarm when this object exceeds user definable limits, as described in the Sequence of Controls.

Note: If the specifications require use of the BACnet protocol, all of the above shall be provided as BACnet objects.

- KW Demand Limiting: *

An energy management strategy that reduces energy consumption when a system's electric power meter exceeds an operator-defined threshold.

When power consumption exceeds defined levels, the system automatically adjust setpoints, de-energizes low priority equipment, and takes other pre-programmed actions to avoid peak demand charges. As the demand drops, the system restores loads in a predetermined manner.

- Occupant Override Switch, or Timed Local Override:

A control option that allows building occupants to override the programmed HVAC schedule for a limited period of time.

When the override time expires, the zone returns to its unoccupied state.

- Occupant Setpoint Adjustment:

A control option that allows building occupants to adjust - within limits set by the HVAC control system - the heating and cooling setpoints of selected zones. Typically the user interface for this function is built into the zone sensor.

- Optimal Start-Up: *

A control strategy that automatically starts an HVAC system at the latest possible time yet ensures comfort conditions by the time the building becomes occupied.

In a typical implementation, a controller measures the temperature of the zone and the outside air. Then, using design heating or cooling capacity at the design outside air temperature, the system computes how long a unit must run at maximum capacity to bring the zone temperature to its occupied setpoint.

The optimal start algorithm often includes a self-learning feature to adjust for variations from design capacity.

A distributed system must use Run on Request with Optimal Start. (See below.)

- Requested, or Run on Request: *

A control strategy that optimizes the runtime of a source piece of equipment that supplies one or more receiving units - such as an air handler unit supplying zone terminal units with heating, cooling, ventilation, or similar service. Source equipment runs only when needed, not on a fixed schedule.

The source equipment runs when one or more receiving units request its services. An operator determines how many requests are required to start the source equipment.

For example, if all the zones in a building are unoccupied and the zone terminal units do not need heating or cooling, the AHU will shut down. However, if a zone becomes occupied or needs cooling, the terminal unit will send a run request to the AHU to initiate the start-up sequence. If this AHU depends on a central chiller, it can send a run request to the chiller.

The run on request algorithm also allows an operator to schedule occupancy for individual zones based on the needs of the occupants without having to adjust the schedules of related AHUs and chillers.

- Trim and Respond, or Setpoint Optimization: *

A control strategy that optimizes the setpoint of a source piece of equipment that supplies one or more receiving units - such as an air handler unit supplying zone terminal units with heating, cooling, ventilation, or similar service.

The source unit communicates with receiving units to determine heating, cooling, and other requirements, and then adjusts its setpoint.

For example, if all zones are comfortable and do not request cooling, the AHU will gradually increase (trim) its supply air setpoint. When a zone requests cooling, the AHU responds by dropping its setpoint. The more zones that request cooling, the more it drops the setpoint. The AHU repeats this process throughout the day to keep zones cool, but with a supply air setpoint that is no cooler than necessary.

Contracting Terms:

- Furnished or Provided:

The act of supplying a device or piece of equipment as required meeting the scope of work specified and making that device or equipment operational. All costs required to furnish the specified device or equipment and make it operational are borne by the division specified to be responsible for providing the device or equipment.

- Install or Installed:

The physical act of mounting, piping or wiring a device or piece of equipment in accordance with the manufacturer's instructions and the scope of work as specified. All costs required to complete the installation are borne by the division specified to include labor and any ancillary materials.

- Interface:

The physical device required to provide integration capabilities from an equipment vendor's product to the control system. The equipment vendor most normally furnishes the interface device. An example of an interface is the chilled water temperature reset interface card provided by the chiller manufacturer in order to allow the control system to integrate the chilled water temperature reset function into the control system.

- Integrate:

The physical connections from a control system to all specified equipment through an interface as required to allow the specified control and monitoring functions of the equipment to be performed via the control system.

APPENDIX B: Abbreviations

The following abbreviations may be used in graphics, schematics, point names, and other UI applications where space is at a premium.

AC - Air Conditioning
ACU - Air Conditioning Unit
AHU - Air Handling Unit
AI - Analog Input
AO - Analog Output
AUTO - Automatic
AUX - Auxiliary
BI - Binary Input
BO - Binary Output
C - Common
CHW - Chilled Water
CHWP - Chilled Water Pump
CHWR - Chilled Water Return
CHWS - Chilled Water Supply
COND - Condenser
CW - Condenser Water
CWP - Condenser Water Pump
CWR - Condenser Water Return
CWS - Condenser Water Supply
DA - Discharge Air
EA - Exhaust Air
EF - Exhaust Fan
EVAP - Evaporators
FCU - Fan Coil Unit
HOA - Hand / Off / Auto
HP - Heat Pump
HRU - Heat Recovery Unit
HTEX - Heat Exchanger
HW - Hot Water
HWP - Hot Water Pump
HWR - Hot Water Return
HWS - Hot Water Supply
MAX - Maximum
MIN - Minimum
MISC - Miscellaneous
NC - Normally Closed
NO - Normally Open
OA - Outdoor Air
PIU - Powered Induction Unit
RA - Return Air
RF - Return Fan
RH - Relative Humidity
RTU - Roof-top Unit
SA - Supply Air
SF - Supply Fan
SP - Static Pressure
TEMP - Temperature
UH - Unit Heater
UV - Unit Ventilator
VAV - Variable Air Volume

VVTU - Variable Volume Terminal Unit
W/ - with
W/O - without
WSHP - Water Source Heat Pump

END OF SECTION 230923

SECTION 23 09 25

SYSTEMS INTEGRATION

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 WORK INCLUDED

- A. This Section specifies the requirements to contract the necessary services of a facility systems integrator, including the requisite hardware and requisite software, development/configuration of the software, and the integration of the hardware and software for the Biddle Airforce Base Bldg. #237 Renovations.
- B. The contractor is responsible for coordination of all aspects of the hardware and software requirements for the new equipment including programming, testing, calibration, control sequences, PLC and PC interfaces. The contractor shall provide new ALC PLC as required for the integration of the new and existing equipment.
- C. General: The control system shall consist of a high-speed, peer-to-peer network of DDC controllers, a control system server, and a web-based operator interface.
- D. System software shall be based on a server/thin-client architecture, designed around the open standards of web technology. The control system server shall be accessed using a Web browser over the control system network, the owner's local area network and (at the owner's discretion) over the Internet. The server shall also act as a "workstation" when running as a server/client platform. Additional clients shall have concurrent access to the "workstation" in this mode.
- E. The intent of the thin-client architecture is to provide operators complete access to the control system via a Web browser. No special software other than a Web browser shall be required to access graphics, point displays, and trends, configure trends, configure points and controllers, or to download programming into the controllers.
- F. System shall use BACnet protocol for communication between the control modules and web server. Communication between the web server and the user's browser shall be HTTP or HTTPS protocol utilizing HTML5. Use of Adobe Flash technology is not acceptable. I/O points, schedules, setpoints, trends, and alarms specified in the Sequence of Operations for HVAC Controls shall be BACnet objects.
- G. All wiring shall be in accordance with Sections 23 09 23 and Owner specifications.
- H. The work shall include all points associated with the new systems installed in Biddle Airforce Base Bldg. #237. Controls Contractor shall be responsible for coordinating, with the electrical contractor, the installation of all interconnecting control wiring between variable speed drives and control instrumentation such as pressure transmitters, switches, and differential pressure transmitters. Power wiring shall be provided by the electrical contractors for all power requirements.
- I. This contractor shall develop a written Functional Acceptance Test (FAT) specifically for the new driver. This test procedure shall be executed by the contractor on site using a test set up with temporary hardware prior to the actual integration of any new PLC's.

1.3 CONTRACTOR QUALIFICATIONS

A. Qualified Systems Integrators: Automated Logic Controls (ALC)

1. Point of Contact:
 - a. Randy Robertson
 - b. Outside Sales Engineer
 - c. 6345 Flank Drive, suite 100
 - d. Harrisburg, PA 17112
 - e. Cell: (717) 798-4066
 - f. randy.robertson@carrier.com

1.4 RELATED WORK

A. This Section shall be used in conjunction with the following other sections and related contract documents to establish the total requirements for the referenced facility systems integration services:

2. Division 00 – All Sections
3. Division 01 – All Sections
4. Division 20 – All Sections
5. Division 23 – All Sections
6. Division 26 – All Sections

B. CAUTION: Use of this Section without including all of the above listed items will result in omission of basic requirements.

C. In the event of a conflict regarding the requirements of this Section and any other sections, the provisions of this Section shall govern.

1.5 SYSTEM DESCRIPTION

A. This Section shall define the requirements for the Contractor. The Contractor shall be responsible for database development, graphics screen(s) development, PLC Programming, other application programs(s) development, and integration and testing of the hardware and software including all final elements (e.g., transmitters, valves, I/O cards, etc.), BAS software and programming.

B. The system configuration and software development shall be in accordance with the following documents:

1. Control Sequence of Operations.
2. P&IDs.
3. Specifications.
4. DMVA Standards.

C. Contractor shall provide all necessary network hardware, bridges, and repeaters for the facility monitoring and control.

D. All necessary coordination, programming, gateways, start-up, calibration, and testing associated with Owner furnished equipment, and wiring/field devices provided by others.

- E. Contractor shall update the existing system architecture AutoCAD file to include the modifications associated with the scope of this project.
- F. Contractor shall add all programming and graphics files associated to the changes required for this project into the owner's existing backup and disaster recovery system.

1.6 QUALITY ASSURANCE

- A. The Contractor shall provide a quality assurance program plan and demonstrate the workings of the quality assurance program. This quality assurance program shall address the work process and shall monitor the quality and conformance for hardware configuration, hardware supply, and applications software configuration/software development.
- B. The quality assurance program plan shall address in detail the methods used to test and certify all components and functions of the system hardware and software to be provided.
- C. Installer shall have an established working relationship with the Control System Manufacturer and have, as a minimum, 5 years demonstrated experience with installation and support of the manufacturer's product
- D. Installer shall have successfully completed Control System Manufacturer's control system training. Upon request, Installer shall present record of completed training including course outlines.

1.7 QUALIFICATIONS

- A. The Contractor shall provide evidence of the experience of at least five (5) years in systems similar to this project in the industrial control industry.
- B. The Contractor shall provide evidence of experience in the successful completion of fast-track projects where design and installation of complex systems was achieved simultaneously.
- C. The Contractor shall provide, as part of the bid, a listing of installations satisfying the above criteria, addresses, telephone numbers, and persons to contact.

1.8 SYSTEM PERFORMANCE

- A. 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 display through the user's web browser.
 - 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, PID loops, and similar control logic shall automatically refresh within 6 sec.
 - 4. Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.
 - 5. Alarm Response Time. An object that goes into alarm shall be annunciated at the browser within 45 sec.

6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 sec.
7. Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
8. Multiple Alarm Annunciation. Each user, connected to network accessing the system through their browser (workstation), shall receive alarms within 5 seconds of one another.
9. Reporting Accuracy. System shall report values with minimum end-to-end accuracy listed in Table 1.
 - a. Table 1: Reporting Accuracy
 - 1) Note 1: Accuracy applies to 10%–100% of scale
 - 2) Note 2: For both absolute and differential pressure
 - 3) Note 3: Not including utility-supplied meters

<u>Measured Variable</u>	<u>Reported Accuracy</u>
Space Temperature	±0.5°C (±1°F)
Ducted Air	±0.5°C (±1°F)
Outside Air	±1.0°C (±2°F)
Dew Point	±1.5°C (±3°F)
Water Temperature	±0.5°C (±1°F)
Delta-T	±0.15° (±0.25°F)
Relative Humidity	±5% RH
Water Flow	±2% of full scale
Airflow (terminal)	±10% of full scale (see Note 1)
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized spaces)	±3% of full scale
Air Pressure (ducts)	±25 Pa (±0.1 in. w.g.)
Air Pressure (space)	±3 Pa (±0.01 in. w.g.)
Water Pressure	±2% of full scale (see Note 2)
Electrical (A, V, W, Power Factor)	±1% of reading (see Note 3)
Carbon Monoxide (CO)	±5% of reading
Carbon Dioxide (CO ₂)	±50 ppm

10. Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2.
 - b. Table 2: Control Stability and Accuracy

<u>Controlled Variable</u>	<u>Control Accuracy</u>	<u>Range of Medium</u>
Air Pressure	±50 Pa (±0.2 in. w.g.) ±3 Pa (±0.01 in. w.g.)	0–1.5 kPa (0–6 in. w.g.) □25 to 25 Pa (□0.1 to 0.1 in. w.g.)
Airflow	±10% of full scale	
Space Temperature	±1.0°C (±2.0°F)	
Duct Temperature	±1.5°C (±3°F)	
Humidity	±5% RH	
Fluid Pressure	±10 kPa (±1.5 psi) ±250 Pa (±1.0 in. w.g.)	MPa (1–150 psi) 0–12.5 kPa (0–50 in. w.g.) differential

1.9 SUBMITTALS

- A. All drawings shall be submitted in reproducible hard copy and electronic format using AutoCAD 2013 or later.

- B. Submit the following information to the Owner with the Bid:
1. Qualifications as described in paragraph 1.6 of this Section.
 2. Details of quality assurance program as described in paragraph 1.5 of this Section.
 3. Catalog cut sheets, circulars, specifications and product data, and printed information in sufficient detail and scope for each component supplied to verify compliance with the hardware requirements of this Section and all related sections.
 4. Specifications, product data, and other printed information in sufficient detail and scope of the software package(s) to verify the compliance with the software requirements of this Section and all related sections.
 5. List of graphic screens to be provided.
 6. Schedule for remaining submittals (as listed below) showing when the items listed are scheduled for completion.
- C. Submit the following information to the Owner within ten (10) weeks of the award of the contract:
1. Loop Sheets - The Systems Integrator shall develop typical point-to-point loop sheets for each physical IO point connected to the Control System.
 2. PLC Panel Riser Diagrams - The Systems Integrator shall develop single line riser diagrams for each of the Control System PLC panels. These single line risers shall detail wire type and conductor quantities required for each field device.
 3. Panel Production Drawings - The Systems Integrator shall develop full-scale detailed panel production drawings. Drawings shall be developed for each Control System PLC node, remote IO node, communication panels, and Control System interface panels as required. Panel design shall be in accordance with UL standards.
 4. Control System Architecture – The Systems Integrator shall develop the Control System architecture drawings. The Control System architecture shall depict all PLC nodes, remote IO nodes, communications panels, and HMI workstations. Communications risers and protocols shall be defined by the Control System architecture.
 5. Software Design Specification - The Systems Integrator shall develop the Software Design Specification (SDS) for the project. The SDS shall define all Control System PLC node programming and sequences of operation. In addition the SDS shall define all of the HMI programming requirements including alarm summaries, historical trend summaries, graphic screen listings and all information required for the proper configuration and set up of the Control System PC network.
 6. Hardware Design Specification - The Systems Integrator shall develop the Hardware Design Specification (HDS) for the project. The HDS shall define all Control System instrumentation and instrumentation specifications furnished for the project.
 5. Functional Design Specification - The Systems Integrator shall develop the Functional Design Specification (FDS) for the project. The FDS shall define all

Control System PLC node programming and sequences of operation. In addition, the FDS shall define all of the HMI programming requirements including alarm summaries, historical trend summaries, graphic screen listings and all information required for the proper configuration and set up of the Control System PC network. The FDS shall define all Control System instrumentation and instrumentation specifications furnished for the project.

- D. Submit the following information to the Owner at the design progress review:
1. Preliminary versions of Control screens, per DMVA Standards, consisting of a minimum of:
 - a. Process Graphics: each a comprehensive picture of a specific segments of the process.
 - b. Alarm Displays: a summary of alarms in text form which is in reverse chronological order with the most recent at the top.
 - c. Summary Displays: provides a number of displays which can be addressed by keyboard or other pointing device.
 - d. Status Displays: a comprehensive set of displays showing the status of the system components. These displays provide the operator with sufficient information to easily identify a failed or malfunctioning system component.
 - e. Faceplate Displays: a comprehensive picture of a conventional analog faceplate.
 - f. Group Displays: a summary of the faceplate displays within text form presenting point, loop, group, or device.
 - g. Tuning Displays: displays designed to allow operator/Engineer interaction(s) to tune process parameters and program/implement control strategies.
 - h. Loop Maintenance Displays: providing a summary of the tuning displays in text form presenting the data shown on the tuning displays.
 2. All documentation shall be in an electronic (PDF) format on a flash drive, and incorporated into the CM's and commissioning agents manuals.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts shall be available for at least five years after completion of this contract.

2.2 COMMUNICATION

- A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.
- B. Install new wiring and network devices as required to provide a complete and workable control network.
- C. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
- D. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information

- such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified in the Sequence of Operations. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.
- E. Building Control Panels and Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. The system shall automatically adjust for daylight saving and standard time as applicable.
 - F. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.
 - G. System shall support Web services data exchange with any other system that complies with XML (extensible markup language) and SOAP (simple object access protocol) standards. Web services support shall as a minimum be provided at the workstation or web server level and shall enable data to be read from or written to the system.
 1. System shall support Web services read data requests by retrieving requested trend data or point values (I/O hardware points, analog value software points, or binary value software points) from any system controller or from the trend history database.
 2. System shall support Web services write data request to each analog and binary object that can be edited through the system operator interface by downloading a numeric value to the specified object.
 3. For read or write requests, the system shall require user name and password authentication and shall support SSL (Secure Socket Layer) or equivalent data encryption.
 4. System shall support discovery through a Web services connection or shall provide a tool available through the Operator Interface that will reveal the path/identifier needed to allow a third party Web services device to read data from or write data to any object in the system which supports this service.
 5. Direct access to trend data shall be provided in order to facilitate historical information stored by the system.
- 2.3 OPERATOR INTERFACE
- A. Hardware.
 1. Server and workstation will be provided by the owner.
 - B. System Software.
 1. Operating System. Web server shall have an industry-standard professional-grade operating system. Operating system shall meet or exceed the DDC System manufacturer's minimum requirements for their software. Acceptable systems include Microsoft Windows 7, 8 or 10, Microsoft Vista, Windows Server 2008 or 2012, Red Hat Enterprise Linux, or Ubuntu Desktop 12.04.
 2. Security. The web server application shall support Transport Layer Security (TLS) with a capability of 256-bit encryption for transmitting private information over the Internet using HTTPS. Additionally, the web server shall have SHA-2 certificate support.
 3. Database. System shall support any JDBC (Java DataBase Connectivity) compliant engine. This includes: MS SQL, My SQL, PostgreSQL and Oracle.
 4. System Graphics. The operator interface software shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.

- a. Minimum graphics resolution shall be 1920 x1080 for display of detailed system graphics.
 - b. Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.
 - c. Animation. Graphics shall be able to animate by displaying different image files for changed object status.
 - d. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
 - e. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in) or shall only require widely available no-cost plug-ins (such as Active-X or Adobe Flash).
5. Custom Graphics. Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system to create and modify graphics that are saved in the same formats as are used for system graphics.
6. Graphics Library. Furnish a complete library of standard HVAC equipment graphics such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.
- C. System Applications. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard PCs with no limit on the number of copies that can be installed under the system license.
 1. Automatic System Database Configuration. Web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
 2. Manual Controller Memory Download. Operators shall be able to download memory from the system database to each controller.
 3. System Configuration. The workstation software shall provide a method of configuring the system. This shall allow for future system changes or additions by users under proper password.
 4. On-Line Help. Provide a context-sensitive, on-line help system to assist the operator in operating and editing the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
 5. Online Video Training. Provide on-line video support to supplement on-line help assistance. Video content shall be relevant and support existing system documentation.
 6. Security. Each operator shall be required to log on to the system with a user name and password in order to view, edit, add, or delete data.
 - a. Operator Access. The user name and password combination shall define accessible viewing, editing, adding, and deleting privileges for that operator. Users with system administrator rights shall be able to create new users and edit the privileges of all existing users. System Administrators shall also be able to vary and deny each operator's privileges based on the geographic location, such as the ability to edit

- operating parameters in Building A, to view but not edit parameters in Building B, and to not even see equipment in Building C.
- b. Password Policy Rules. System administrator shall invoke policies for minimum password strength, including number of characters, special characters and numbers, upper and lower case, etc.
 - c. Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. This auto logoff time shall be user adjustable.
 - d. Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.
- 7. System Diagnostics. The system shall automatically monitor the operation of all building management panels and controllers. The failure of any device shall be annunciated to the operator.
 - 8. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in the Sequences of Operations. Alarms shall be BACnet alarm objects and shall use BACnet alarm services.
 - 9. Alarm Messages. Alarm messages shall use the English language descriptor for the object in alarm in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying on acronyms or mnemonics.
 - 10. Alarm Reactions. Operator shall be able to configure (by object) what, if any actions are to be taken during an alarm. As a minimum, the workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send SMS text, and audibly annunciate.
 - 11. Alarm and Event log. Operators shall be able to view all system alarms and changes of state from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and delete alarms, and archive closed alarms to the web server hard.
 - 12. Trend Logs. The operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as specified in the Sequences of Operations. Trends shall be BACnet trend objects. As a minimum, all physical points in the system shall be trended within the local controller (AAC, ASC, BC) for at least 277 samples per point. Selected points, as desired, shall be available for historical archiving within the server. The historical archiving capability cannot be less than 2 years.
 - 13. Object and Property Status and Control. Provide a method for the operator to view, and edit if applicable, the status of any object or property in the system. The status shall be available by menu, on graphics, or through custom programs.
 - 14. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
 - 15. Audit and Security Detail. All users accessing the system shall have their actions recorded. Information recorded shall include: login/logout time and date; system modifications – with before and after values; ability to report user activity based on individual and/or date and time.
 - 16. Standard Reports. Furnish the following standard system reports:
 - a. Objects. System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.

- b. Alarm Summary. Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.
 - c. Logs. System shall log the following to a database or text file and shall retain data for an adjustable period:
 - 1) Alarm History.
 - 2) Trend Data. Operator shall be able to select trends to be logged.
- 17. Environmental Index. System shall monitor all occupied zones and compile an index that provides a numerical indication of the environmental comfort within the zone. As a minimum, this indication shall be based upon the deviation of the zone temperature from the heating or cooling setpoint. If humidity is being measured within the zone then the environmental index shall be adjusted to reflect a lower comfort level for high or low humidity levels. Similarly, if carbon dioxide levels are being measured as an indication of ventilation effectiveness then the environmental index shall be adjusted to indicate degraded comfort at high carbon dioxide levels. Other adjustments may be made to the environmental index based upon additional measurements. The system shall maintain a trend of the environmental index for each zone in the trend log. The system shall also compute an average comfort index for every building included in this contract and maintain trend logs of these building environmental indices. Similarly, the system shall compute the percentage of occupied time that comfortable conditions were maintained within the zones. Through the UI the user shall be able to add a weighting factor to adjust the contribution of each zone to the average index based upon the floor area of the zone, importance of the zone, or other static criteria.
- 18. Custom Reports. Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, that analyze data using common algebraic calculations, and that present results in tabular or graphical format. Reports shall be launched from the operator interface.
- 19. Time Lapse Graphic Replay. Operator shall be able to “replay” any graphic in the system to see how key values changed over an operator-selected period of time. Operator shall be able to select the starting date/time for this display and the end date/time or the display period. System shall then display the graphic as it would have looked at the beginning of that period, displaying key data, dynamic colors, etc. based upon values recorded at the start time. When the operator starts the replay the graphics and key values shall dynamically change to produce the effect of “fast forwarding” through the designated period of time. Once the system has been operational for at least 30 days, the contractor shall demonstrate that up to 24 hours of data from within the last 30 days can be replayed on any graphic page. Owner’s representative shall choose the graphic pages for this demonstration at the time of the demonstration.

2.4 CONTROLLER SOFTWARE

- A. Furnish the following applications for building and energy management. All software applications shall reside and operate in the system controllers. Applications shall be editable through operator workstation, web browser interface, or workstation.
- B. Scheduling. Provide the capability to execute control functions according to a user created or edited schedule. Each schedule shall provide the following schedule options as a minimum:
 - 1. Weekly Schedule. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
 - 2. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule has executed, the system shall discard and replace the exception schedule with the standard schedule for that day of the week.
- C. Holiday Schedules. Provide the capability for the operator to define up to 24 special or holiday schedules. These schedules will be repeated each year. The operator shall be

able to define the length of each holiday period. System Coordination. Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.

- D. Binary Alarms. Each binary object shall have the capability to be configured to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.
- E. Analog Alarms. Each analog object shall have both high and low alarm limits. The operator shall be able to enable or disable these alarms.
- F. Alarm Reporting. The operator shall be able to determine the action to be taken in the event of an alarm. An alarm shall be able to start programs, print, be logged in the event log, generate custom messages, and display on graphics.
- G. Remote Communication. System shall automatically contact operator workstation or server on receipt of critical alarms. If no network connection is available, system shall use a modem connection.
- H. Demand Limiting.
 - 1. The demand-limiting program shall monitor building power consumption from a building power meter (provided by others) which generates pulse signals or a BACnet communications interface. An acceptable alternative is for the system to monitor a watt transducer or current transformer attached to the building feeder lines.
 - 2. When power consumption exceeds adjustable levels, system shall automatically adjust setpoints, de-energize low-priority equipment, and take other programmatic actions to reduce demand as specified in the Sequence of Operations. When demand drops below adjustable levels, system shall restore loads as specified.
- I. Maintenance Management. The system shall be capable of generating maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits. Configure and enable maintenance alarms as specified in the Sequence of Operations.
- J. Sequencing. Application software shall sequence chillers, boilers, and pumps as specified in the Sequence of Operations.
- K. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs. The calculation interval, PID gains, and other tuning parameters shall be adjustable by a user with the correct security level.
- L. Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.
- M. Energy Calculations.
 - 1. The system shall accumulate and convert instantaneous power (kW) or flow rates (L/s [gpm]) to energy usage data.
 - 2. The system shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.
- N. Anti-Short Cycling. All binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.
- O. On and Off Control with Differential. Provide an algorithm that allows a binary output to be cycled based on a controlled variable and a setpoint. The algorithm shall be direct-acting or reverse-acting.
- P. Runtime Totalization. Provide software to totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as specified in the Sequence of Operations.

2.5 CONTROLLERS

- A. General. Provide an adequate number of Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), Smart Actuators (SA), and

Smart Sensors (SS) as required to achieve performance specified. Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of BACnet Smart Actuators and Smart Sensors

B. BACnet.

1. Building Controllers (BCs): Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L, and shall be listed as a certified B-BC in the BACnet Testing Laboratories (BTL) Product Listing.
2. Advanced Application Controllers (AACs): Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.
3. Application Specific Controllers (ASCs): Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.
4. Smart Actuators (SAs): An actuator which is controlled by a network connection rather than a binary or analog signal (0-10v, 4-20mA, relay, etc.). Each SA shall conform to BACnet Smart Actuator (B-SA) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-SA in the BACnet Testing Laboratories (BTL) Product Listing.
5. Smart Sensors (SSs): A sensor which provides information to the BAS via network connection rather than a binary or analog signal (0-10000 ohm, 4-20mA, dry contact, etc.). Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ANSI/ASHRAE 135, BACnet Annex L and shall be listed as a certified B-SS in the BACnet Testing Laboratories (BTL) Product Listing.
6. BACnet Communication.
 - a. Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.
 - b. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
 - c. Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
 - d. Each ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
 - e. Each SA shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
 - f. Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using ARCNET or MS/TP Data Link/Physical layer protocol.

C. Security.

1. Provide BACnet firewall capability, as defined in the BACnet standard, for controllers that are IP capable.

D. Communication.

1. Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
2. Signal Management. BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.

3. Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.
4. Stand-Alone Operation. Each piece of equipment specified in Section 23 09 93 shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network such as outdoor air conditions, supply air or water temperature coming from source equipment, etc.
- E. Environment. Controller hardware shall be suitable for anticipated ambient conditions.
 1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at $\square 29^{\circ}\text{C}$ to 60°C ($\square 20^{\circ}\text{F}$ to 140°F).
 2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).
- F. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to a field-removable modular terminal strip or to a termination card connected by a ribbon cable. Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.
- G. Memory.
 1. Controller memory shall support operating system, database, and programming requirements.
 2. Each BC and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.
 3. Each ASC and SA shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.
- H. Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
- I. Transformer. ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.

2.6 INPUT AND OUTPUT INTERFACE

- A. General. Hard-wire input and output points to BCs, AACs, ASCs, or SAs.
- B. Protection. All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground shall cause no damage to the controller. All input and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no controller damage.
- C. Binary Inputs. Binary inputs shall allow the monitoring of ON/OFF signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.
- D. Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall also accumulate up to 10 pulses per second.
- E. Analog Inputs. Analog inputs shall monitor low-voltage (0–10 Vdc), current (4–20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
- F. Binary Outputs. Binary outputs shall provide for ON/OFF operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on Building Controllers have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.

- G. Analog Outputs. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0–10 Vdc or a 4–20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.
 - H. Tri-State Outputs. Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.
 - I. Universal Inputs and Outputs. Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.
 - J. System Object Capacity. The system size shall be expandable to at least twice the number of input/output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system
- 2.7 POWER SUPPLIES AND LINE FILTERING
- A. Power Supplies. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
 - 1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.
 - a. Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
 - b. Line voltage units shall be UL recognized and CSA listed.
 - B. Power Line Filtering.
 - 1. Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have:
 - a. Dielectric strength of 1000 V minimum
 - b. Response time of 10 nanoseconds or less
 - c. Transverse mode noise attenuation of 65 dB or greater
 - d. Common mode noise attenuation of 150 dB or greater at 40–100 Hz
- 2.8 AUXILIARY CONTROL DEVICES
- A. Motorized Control Dampers, unless otherwise specified elsewhere, shall be as follow.
 - 1. Type. Control dampers shall be the parallel or opposed-blade type as specified below or as scheduled on drawings.
 - a. Outdoor and return air mixing dampers and face-and-bypass dampers shall be parallel-blade and shall direct airstreams toward each other.
 - b. Other modulating dampers shall be opposed-blade.
 - c. Two-position shutoff dampers shall be parallel- or opposed-blade with blade and side seals.
 - 2. Frame. Damper frames shall be galvanized steel channel or extruded aluminum with reinforced corner bracing.
 - 3. Blades. Blades shall be suitable for medium velocity (10 m/s [2000 fpm]) performance.
 - 4. Shaft Bearings. Damper shaft bearings shall be as recommended by manufacturer for application, oil impregnated sintered bronze, or better.
 - 5. Seals. Blade edges and frame top and bottom shall have replaceable seals of butyl rubber or neoprene. Side seals shall be spring-loaded stainless steel. Blade seals shall leak no more than 50 L/s·m² (10 cfm per ft²) at 1000 Pa (4 in. w.g.) differential

6. pressure. Blades shall be airfoil type suitable for wide-open face velocity of 7.5 m/s (1500 fpm). Sections. Individual damper sections shall not exceed 125 cm × 150 cm (48 in. × 60 in.). Each section shall have at least one damper actuator.
 7. Modulating dampers shall provide a linear flow characteristic where possible.
 8. Linkages. Dampers shall have exposed linkages.
- B. Electric Damper and Valve Actuators.
1. Provide actuation as manufactured by Belimo and selected for applicable service.
 2. Stall Protection. Mechanical or electronic stall protection shall prevent actuator damage throughout the actuator's rotation.
 3. Spring-return Mechanism. Actuators used for power-failure and safety applications shall have an internal mechanical spring-return mechanism or an uninterruptible power supply (UPS).
 4. Signal and Range. Proportional actuators shall accept a 0–10 Vdc or a 0–20 mA control signal and shall have a 2–10 Vdc or 4–20 mA operating range. (Floating motor actuators may be substituted for proportional actuators in terminal unit applications)
 5. Wiring. 24 Vac and 24 Vdc actuators shall operate on Class 2 wiring.
 6. Manual Positioning. Operators shall be able to manually position each actuator when the actuator is not powered. Non-spring-return actuators shall have an external manual gear release. Spring-return actuators with more than 7 N·m (60 in.-lb) torque capacity shall have a manual crank.
 7. Zone Valve Actuators. For modulation of actuators in HVAC systems, actuator sizing should be in accordance with the valve manufactures' specifications. The actuator shall be powered by 24 volts AC. The actuator shall be controlled by commands from the terminal unit controller. Actuator shall be capable of modulating to any position as directed by the terminal unit controller. In addition, the actuator shall provide positive feedback to the terminal unit controller. The terminal unit controller actuator command is not considered positive feedback. Actuator shall be capable of providing fail open, fail close, or fail last position as determined by the project requirements.
 - a. Electronic Fail Safe is acceptable for terminal unit and zone valve applications
- C. Control Valves.
1. Control valves shall be two-way or three-way type for two-position or modulating service.
 2. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
 - a. Water Valves:
 - 1) Two-way: 150% of total system (pump) head.
 - 2) Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
 - b. Steam Valves: 150% of operating (inlet) pressure.
 3. Water Valves.
 - a. Body and trim style and materials shall be in accordance with manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.
 - b. Sizing Criteria:
 - 1) Two-position service: Line size.
 - 2) Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 5 psi, whichever is greater.
 - 3) Three-way modulating service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), 35 kPa (5 psi) maximum.

- c. Valves ½ in. through 2 in. shall be bronze body or cast brass ANSI Class 250, spring-loaded, PTFE packing, quick opening for two-position service. Two-way valves to have replaceable composition disc or stainless steel ball.
 - d. Valves 2½ in. and larger shall be cast iron ANSI Class 125 with guided plug and PTFE packing.
 - e. Water valves shall fail normally open or closed, as scheduled on plans, or as follows:
 - 1) Terminal zone valves—fail in place.
 - 2) Heating coils in air handlers—normally open.
 - 3) Chilled water control valves—normally closed.
 - 4) Other applications—as scheduled or as required by sequences of operation.
- 4. Steam Valves.
 - a. Body and trim materials shall be in accordance with manufacturer's recommendations for design conditions and service with linear ports for modulating service.
 - b. Sizing Criteria:
 - 1) Two-position service: pressure drop 10% to 20% of inlet psig.
 - 2) Modulating service: 100 kPa (15 psig) or less; pressure drop 80% of inlet psig.
 - 3) Modulating service: 101 to 350 kPa (16 to 50 psig); pressure drop 50% of inlet psig.
 - 4) Modulating service: over 350 kPa (50 psig); pressure drop as scheduled on plans.
- D. Temperature Sensors.
 - 1. Type. Temperature sensors shall be thermistor (10k Type2).
 - 2. Duct Sensors. Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 1.5m (5 ft) in length per 1 m² (10 ft²) of duct cross-section.
 - 3. Immersion Sensors. Provide immersion sensors with a separable stainless steel well. Well pressure rating shall be consistent with system pressure it will be immersed in. Well shall withstand pipe design flow velocities.
 - 4. Space Sensors. Space sensors shall have setpoint adjustment, override switch, display, and communication port as shown.
 - 5. Differential Sensors. Provide matched sensors for differential temperature measurement.
- E. Humidity Sensors.
 - 1. Duct and room sensors shall have a sensing range of 20%–80%.
 - 2. Duct sensors shall have a sampling chamber.
 - 3. Outdoor air humidity sensors shall have a sensing range of 20%–95% RH and shall be suitable for ambient conditions of -40°C–75°C (-40°F–170°F).
 - 4. Humidity sensors shall not drift more than 1% of full scale annually.
- F. Flow Switches. Flow-proving switches shall be paddle (water service only) or differential pressure type (air or water service) as shown. Switches shall be UL listed, SPDT snap-acting, and pilot duty rated (125 VA minimum).
 - 1. Paddle switches shall have adjustable sensitivity and NEMA 1 enclosure unless otherwise specified.
 - 2. Differential pressure switches shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.
- G. Relays.
 - 1. Control Relays. Control relays shall be plug-in type, UL listed, and shall have dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
 - 2. Time Delay Relays. Time delay relays shall be solid-state plug-in type, UL listed, and shall have adjustable time delay. Delay shall be adjustable ±100% from

setpoint shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.

- H. Override Timers.
 - 1. Unless implemented in control software, override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration required by application. Provide 0–6 hour calibrated dial unless otherwise specified. Flush mount timer on local control panel face or where shown.
- I. Current Transmitters.
 - 1. AC current transmitters shall be self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4–20 mA two-wire output. Full-scale unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment. Unit accuracy shall be $\pm 1\%$ full-scale at 500 ohm maximum burden.
 - 2. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.
 - 3. Unit shall be split-core type for clamp-on installation on existing wiring.
- J. Current Transformers.
 - 1. AC current transformers shall be UL/CSA recognized and shall be completely encased (except for terminals) in approved plastic material.
 - 2. Transformers shall be available in various current ratios and shall be selected for $\pm 1\%$ accuracy at 5 A full-scale output.
 - 3. Use fixed-core transformers for new wiring installation and split-core transformers for existing wiring installation.
- K. Voltage Transmitters.
 - 1. AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4–20 mA output with zero and span adjustment.
 - 2. Adjustable full-scale unit ranges shall be 100–130 Vac, 200–250 Vac, 250–330 Vac, and 400–600 Vac. Unit accuracy shall be $\pm 1\%$ full-scale at 500 ohm maximum burden.
 - 3. Transmitters shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized at 600 Vac rating.
- L. Voltage Transformers.
 - 1. AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.
 - 2. Transformers shall be suitable for ambient temperatures of 4°C–55°C (40°F–130°F) and shall provide $\pm 0.5\%$ accuracy at 24 Vac and 5 VA load.
 - 3. Windings (except for terminals) shall be completely enclosed with metal or plastic.
- M. Power Monitors.
 - 1. Selectable rate pulse output for kWh reading, 4–20 mA output for kW reading, N.O. alarm contact, and ability to operate with 5.0 amp current inputs or 0–0.33 volt inputs.
 - 2. 1.0% full-scale true RMS power accuracy, ± 0.5 Hz, voltage input range 120–600 V, and auto range select.
 - 3. Under voltage/phase monitor circuitry.
 - 4. NEMA 1 enclosure.
 - 5. Current transformers having a 0.5% FS accuracy, 600 VAC isolation voltage with 0–0.33 V output. If 0–5 A current transformers are provided, a three-phase disconnect/shorting switch assembly is required.
- N. Hydronic Flowmeters
 - 1. Insertion-Type Turbine Meter
 - a. Dual counter-rotating axial turbine elements, each with its own rotational sensing system, and an averaging circuit to reduce measurement errors due to swirl and flow profile distortion. Single turbine for piping 2 inches and smaller. Flow sensing turbine rotors shall be non-metallic and not impaired by magnetic drag.

- b. Insertion type complete with 'hot-tap' isolation valves to enable sensor removal without water supply system shutdown.
 - c. Sensing method shall be impedance sensing (non magnetic and nonphotoelectric)
 - d. Volumetric accuracy
 - 1) $\pm 0.5\%$ of reading at calibrated velocity
 - 2) $\pm 1\%$ of reading from 3 to 30 ft/s (10:1 range)
 - 3) $\pm 2\%$ of reading from 0.4 to 20 ft/s (50:1 range)
 - e. Each sensor shall be individually calibrated and tagged accordingly against the manufacturer's primary standards which must be accurate to within 0.1% of flow rate and traceable to the National Institute of Standards and Technology (NIST).
 - f. Maximum operating pressure of 400 psi and maximum operating temperature of 95°C (200°F) continuous or 105°C (220°F) peak.
 - g. All wetted metal parts shall be constructed of 316 stainless steel.
 - h. Analog outputs shall consist of noninteractive zero and span adjustments, a DC linearity of 0.1% of span, voltage output of 0-10 Vdc, and current output of 4-20 mA.
2. Magnetic Flow-Tube Type Flowmeter
- a. Sensor shall be a magnetic flowmeter, which utilizes Faraday's Law to measure volumetric fluid flow through a pipe. The flowmeter shall consist of two elements, the sensor and the electronics. The sensor shall generate a measuring signal proportional to the flow velocity in the pipe. The electronics shall convert this EMF into a standard current output.
 - b. Electronic replacement shall not affect meter accuracy (electronic units are not matched with specific sensors).
 - c. Four-wire, externally powered, magnetic type flow transmitter with adjustable span and zero, integrally mounted to flow tube. Output signal shall be a digital pulse proportional to the flow rate (to provide maximum accuracy and to handle abrupt changes in flow). Standard 4-20 mA or 0-10 Vdc outputs may be used provided accuracy is as specified.
 - d. Flow Tube:
 - 1) ANSI class 150 psig steel
 - 2) ANSI flanges
 - 3) Protected with PTFE, PFA, or ETFE liner rated for 120°C (245°F) minimum fluid temperature
 - e. Electrode and grounding material
 - 1) 316L Stainless steel or Hastelloy C
 - 2) Electrodes shall be fused to ceramic liner and not require o-rings.
 - f. Electrical Enclosure: NEMA 4, 7
 - g. Approvals:
 - 1) UL or CSA.
 - 2) NSF Drinking Water approval for domestic water applications
 - h. Performance
 - 1) Accuracy shall be $\pm 0.5\%$ of actual reading from 3 to 30 ft/s flow velocities, and 0.015 ft/s from 0.04 to 3 ft/s.
 - 2) Stability: 0.1% of rate over six months.
 - 3) Meter repeatability shall be $\pm 0.1\%$ of rate at velocities > 3 ft/s.
3. Magnetic Insertion-Type Flowmeter
- a. Magnetic Faraday point velocity measuring device.
 - b. Insertion type complete with hot-tap isolation valves to enable sensor removal without water supply system shutdown.
 - c. 4-20 mA transmitter proportional to flow or velocity.
 - d. Accuracy: larger of 1% of reading and 0.2 ft/s.
 - e. Flow range: 0.2 to 20 ft/s, bidirectional.

- f. Each sensor shall be individually calibrated and tagged accordingly against the manufacturer's primary standards which must be accurate to within 0.1% of flow rate and traceable to the National Institute of Standards and Technology (NIST).
 - 4. Vortex Shedding Flowmeter
 - a. Output: 4-20 mA, 0-10 Vdc, 0-5 Vdc.
 - b. Maximum Fluid Temperature: 427 °C (800 °F).
 - c. Wetted Parts: Stainless Steel.
 - d. Housing: NEMA 4X.
 - e. Turndown: 25:1 minimum.
 - f. Accuracy: 0.5% of calibrated span for liquids, 1% of calibrated span for steam and gases.
 - g. Body: Wafer style or ANSI flanged to match piping specification.
 - 5. Transit-Time Ultrasonic Flowmeter
 - a. Clamp-On transit-time ultrasonic flowmeter
 - b. Wide-Beam transducer technology
 - c. 4-20 mA transmitter proportional to flow or velocity.
 - d. Accuracy: 0.5% of reading in range 1 to 30 ft/s, 0.001 ft/s sensitivity.
- O. Thermal Energy Meters
 - 1. Matched RTD, solid state, or thermistor temperature sensors with a differential temperature accuracy of $\pm 0.08^{\circ}\text{C}$ ($\pm 0.15^{\circ}\text{F}$).
 - 2. Flow meter: See "Hydronic Flowmeters" section.
 - 3. Unit accuracy of $\pm 1\%$ factory calibrated, traceable to NIST with certification.
 - 4. NEMA 1 enclosure.
 - 5. Panel mounted display.
 - 6. UL listed.
 - 7. Isolated 4–20 ma signals for energy rate and supply and return temperatures and flow.
- P. Current Switches.
 - 1. Current-operated switches shall be self-powered, solid-state with adjustable trip current. Select switches to match application current and DDC system output requirements.
- Q. Pressure Transducers.
 - 1. Transducers shall have linear output signal and field-adjustable zero and span.
 - 2. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage.
 - 3. Water pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi). Transducer shall have 4–20 mA output, suitable mounting provisions, and block and bleed valves.
 - 4. Water differential pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi). Over-range limit (differential pressure) and maximum static pressure shall be 2000 kPa (300 psi.) Transducer shall have 4–20 mA output, suitable mounting provisions, and 5-valve manifold.
- R. Differential Pressure Switches. Differential pressure switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum) and shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.
- S. Pressure-Electric (PE) Switches.
 - 1. Shall be metal or neoprene diaphragm actuated, operating pressure rated for 0–175 kPa (0–25 psig), with calibrated scale minimum setpoint range of 14–125 kPa (2–18 psig) minimum, UL listed.
 - 2. Provide one- or two-stage switch action (SPDT, DPST, or DPDT) as required by application. Electrically rated for pilot duty service (125 VA minimum) and /or for motor control.
 - 3. Switches shall be open type (panel-mounted) or enclosed type for remote installation. Enclosed type shall be NEMA 1 unless otherwise specified.

4. Each pneumatic signal line to PE switches shall have permanent indicating gauge.
- 2.9 LOCAL CONTROL PANELS.
- A. Indoor control cabinets shall be fully enclosed NEMA 1 construction with hinged door and removable subpanels.
 - B. Terminal equipment enclosures will be constructed of lightweight durable metal with Lexan cover.
 - C. Interconnections between internal and face-mounted devices shall be prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600 volt service, individually identified per control/ interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
 - D. Provide ON/OFF power switch with overcurrent protection for control power sources to each local panel.
- 2.10 WIRING AND RACEWAYS
- A. General. Provide copper wiring, plenum cable, and raceways as specified in applicable sections of Division 26.
 - B. Insulated wire shall use copper conductors and shall be UL listed for 90°C (200°F) minimum service.
- 2.11 FIBER OPTIC CABLE SYSTEM
- A. Optical Cable. Optical cables shall be duplex 900 mm tight-buffer construction designed for intra-building environments. Sheath shall be UL listed OFNP in accordance with NEC Article 770. Optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125mm.
 - B. Connectors. Field terminate optical fibers with ST type connectors. Connectors shall have ceramic ferrules and metal bayonet latching bodies.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the architect/engineer for resolution before rough-in work is started.
- B. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.
- C. The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate—or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others—the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others.

3.2 PROTECTION

- A. The contractor shall protect all work and material from damage by his/her work or EMPLOYEES AND SHALL BE LIABLE FOR ALL DAMAGE THUS CAUSED.
- B. The contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The contractor shall protect any material that is not immediately installed. The contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.3 COORDINATION

A. Site.

1. Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment.
2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.

B. Test and Balance.

1. The contractor (if necessary) shall provide the T&B contractor with test and balance software and cable to interface to the control system for test and balance purposes.
2. The contractor shall provide training in the use of these tools.
3. The tools used during the test and balance process will be returned at the completion of the testing and balancing process.
4. If interfacing capability cannot be provided, the contractor will assist the T&B contractor for the entirety of the test and balance process.

C. Life Safety.

1. Duct smoke detectors required for air handler shutdown are provided by others. Interlock smoke detectors to air handlers for shutdown as specified in the Sequence of Operations.
2. Smoke dampers and actuators required for duct smoke isolation are provided by others. Interlock smoke dampers to air handlers as specified in the Sequence of Operations.
3. Fire and smoke dampers and actuators required for fire-rated walls are provided by others. Fire and smoke damper control is provided by others.

3.4 GENERAL WORKMANSHIP

- A. Install equipment, piping, and wiring/raceway parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.
- B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- C. Install equipment in readily accessible locations as defined by the National Electrical Code (NEC).
- D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- E. All equipment, installation, and wiring shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.5 FIELD QUALITY CONTROL

- A. All work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances as identified in Section (Codes and Standards).
- B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship.

3.6 WIRING

- A. All control and interlock wiring shall comply with national and local electrical codes, and electrical specifications. Where the requirements of this section differ from other divisions of this specification, the requirements of this section shall take precedence.

- B. All NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway according to NEC and electrical specification requirements.
- C. All low-voltage wiring shall meet NEC Class 2 requirements. Low-voltage power circuits shall be subfused when required to meet Class 2 current limit.
- D. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL listed for the intended application.
- E. All wiring in mechanical, electrical, or service rooms – or where subject to mechanical damage – shall be installed in raceway at levels below 3 m (10ft).
- F. Do not install Class 2 wiring in raceways containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).
- G. Do not install wiring in raceway containing tubing.
- H. Where Class 2 wiring is run exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 3 m (10 ft) intervals.
- I. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.
- J. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.
- K. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- L. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the contractor shall provide step-down transformers.
- M. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
- N. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.
- O. Size of raceway and size and type of wire shall be the responsibility of the contractor in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.
- P. Include one pull string in each raceway 2.5 cm (1 in.) or larger.
- Q. Use color-coded conductors throughout with conductors of different colors.
- R. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.
- S. Conceal all raceways except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 15 cm (6 in.) from high-temperature equipment (e.g. steam pipes or flues).
- T. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.
- U. Adhere to electrical specification requirements where raceway crosses building expansion joints.
- V. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of vertical raceways.
- W. The contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- X. Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Flexible metal raceway less than ½ in. electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.
- Y. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

3.7 COMMUNICATION WIRING

- A. The contractor shall adhere to the items listed in the "Wiring" article in Part 3.7 of the specification.
- B. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.
- C. Do not install communication wiring in raceways and enclosures containing Class 1 or other Class 2 wiring.
- D. Maximum pulling, tension, and bend radius for the cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.
- E. Contractor shall verify the integrity of the entire network following cable installation. Use appropriate test measures for each particular cable.
- F. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to manufacturer's instructions.
- G. All runs of communication wiring shall be unspliced length when that length is commercially available.
- H. All communication wiring shall be labeled to indicate origination and destination data.
- I. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."
- J. BACnet Arcnet or MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:
 - 1. Arcnet
 - a. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 nominal. Distributed capacitance between conductors shall be less than 12.5 pF per foot (41 pF per meter.)
 - b. The maximum length of an Arcnet segment is 610 meters (2000 ft) with AWG 22 cable.
 - c. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
 - d. An Arcnet network shall have no T connections.
 - 2. MS/TP
 - a. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot.)
 - b. The maximum length of an MS/TP segment is 1200 meters (4000 ft) with AWG 18 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485
 - c. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
 - d. An MS/TP EIA-485 network shall have no T connections.

3.8 INSTALLATION OF SENSORS

- A. Install sensors in accordance with the manufacturer's recommendations.
- B. Mount sensors rigidly and adequately for environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by wall framing.
- D. All wires attached to sensors shall be sealed in their raceways or in the wall to stop air transmitted from other areas from affecting sensor readings.

- E. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
- F. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 1 ft. of sensing element for each 1 ft² of coil area.
- G. Do not install temperature sensors within the vapor plume of a humidifier. If installing a sensor downstream of a humidifier, install it at least 10 ft. downstream.
- H. All pipe-mounted temperature sensors shall be installed in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.
- I. Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.
- J. Differential Air Static Pressure.
- K. Supply Duct Static Pressure. Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.
 - 1. Return Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor.
 - 2. Building Static Pressure. Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover.
 - 3. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
 - 4. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.
 - 5. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shut-off valves installed before the tee.
- L. Smoke detectors, low limit temperature sensors, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.
- M. Install humidity sensors for duct mounted humidifiers at least 10 ft. downstream of the humidifier. Do not install filters between the humidifier and the sensor.

3.9 FLOW SWITCH INSTALLATION

- A. Use correct paddle for pipe diameter.
- B. Adjust flow switch according to manufacturer's instructions.

3.10 ACTUATORS

- A. General. Mount and link control damper actuators according to manufacturer's instructions.
 - 1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.
 - 2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
 - 3. Provide all mounting hardware and linkages for actuator installation.
- B. Electric/ Electronic

1. Dampers: Actuators shall be direct mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° travel available for tightening the damper seal. Actuators shall be mounted following manufacturer's recommendations.
2. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.11 IDENTIFICATION OF HARDWARE AND WIRING

- A. All wiring and cabling, including that within control panels, shall be labeled.
- B. All pneumatic tubing shall be labeled at each end within 2 in. of termination with a descriptive identifier.
- C. Permanently label or code each point of field terminal strips to show the instrument or item served.
- D. Identify control panels with minimum ½ in. letters on laminated plastic nameplates.
- E. Identify all other control components with labels.
- F. Control System Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.
- G. Identifiers shall match record documents.

3.12 CONTROLLERS

- A. Provide a separate controller for each AHU, Hot Water system, Chilled Water system or other HVAC system. A DDC controller may control more than one system provided that all points associated with the system are assigned to the same DDC controller. Points used for control loop reset, such as outside air or space temperature, are exempt from this requirement.
- B. Building Controllers and Custom Application Controllers shall be selected to provide the required I/O point capacity required to monitor all of the hardware points listed in the Sequence of Operation.

3.13 PROGRAMMING

- A. Provide sufficient internal memory for the specified sequences of operation and trend logging
- B. Point Naming. Name points as shown on the equipment points list provided with each sequence of operation. See Sequence of Operations. If character limitations or space restrictions make it advisable to shorten the name, the abbreviations given in the Sequence of Operations may be used. Where multiple points with the same name reside in the same controller, each point name may be customized with its associated Program Object number. For example, "Zone Temp 1" for Zone 1, "Zone Temp 2" for Zone 2.
- C. Operator Interface.
 1. Standard Graphics. Provide graphics for all mechanical systems and floor plans of the building. This includes each chilled water system, hot water system, chiller, boiler, air handler, and all terminal equipment. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as setpoints. As a minimum, show on each equipment graphic the input and output points and relevant calculated points as indicated on the applicable Points List in Section 23.
 2. The contractor shall provide necessary labor to start up and troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, and any third-party software installation and integration required for successful operation of the operator interface.

3.14 CONTROL SYSTEM CHECKOUT AND TESTING

- A. Startup Testing. All testing listed in this article shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the owner's representative is notified of the system demonstration
1. The contractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.
 2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
 3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturers' recommendations.
 4. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
 5. Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The contractor shall check all control valves and automatic dampers to ensure proper action and closure. The contractor shall make any necessary adjustments to valve stem and damper blade travel.
 6. Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops.
 7. Alarms and Interlocks:
 - a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
 - b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
 - c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

3.15 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

- A. Demonstration.
1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.
 2. The tests described in this section are to be performed in addition to the tests that the contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the "Control System Checkout and Testing" article in Part 3 of this specification. The engineer will be present to observe and review these tests. The engineer shall be notified at least 10 days in advance of the start of the testing procedures.
 3. The demonstration process shall follow that approved in Part 1, "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.
 4. The contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point

and system. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.

5. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
6. Demonstrate compliance with Part 1, "System Performance."
7. Demonstrate compliance with sequences of operation through all modes of operation.
8. Demonstrate complete operation of operator interface.
9. Additionally, the following items shall be demonstrated:
 - a. DDC loop response. The contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.
 - b. Demand limiting. The contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting set point, and the status of sheddable equipment outputs.
 - c. Optimum start/stop. The contractor shall supply a trend data output showing the capability of the algorithm. The change-of-value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.
 - d. Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the architect/engineer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.
10. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests

B. Acceptance.

1. All tests described in this specification shall have been performed to the satisfaction of both the engineer and owner prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the engineer. Such tests shall then be performed as part of the warranty.
2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1, "Submittals."

3.16 CLEANING

- A. The contractor shall clean up all debris resulting from his/her activities daily. The contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.
- B. At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.

3.17 TRAINING

- A. Provide (8) hours of onsite training for a designated staff of Owner's representatives.

3.18 START-UP AND CHECKOUT PROCEDURES

- A. Start up, check out, and test all hardware and software and verify communication between all components.
 - 1. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
 - 2. Verify that all analog and binary input/output points read properly.
 - 3. Verify alarms and interlocks.
 - 4. Verify operation of the integrated system.

END OF SECTION 230925

SECTION 23 09 93

SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

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 Section Includes

- A. RTU-1 Control
- B. RTU-2 & RTU-3 Control
- C. RTU-4 Control (Base-Bid #2)
- D. ERV-1 Control
- E. VAV Control
- F. UH Control
- G. Mini-Split Control
- H. HHW Boiler Control
- I. Water Heater Control
- J. DCW Meter
- K. NG Meter
- L. Electric Meter
- M. Outside Air Conditions

1.02 RTU-1 Control (Typical 1)

- Run Conditions - Requested:
 - The unit shall run whenever:
 - Any zone is occupied.
 - OR a definable number of unoccupied zones need heating or cooling.
 - ERV-1 shall be operational during occupied hours of the RTU
- Freeze Protection:
 - The unit shall shut down and generate an alarm upon receiving a freezestat status.
- High Static Shutdown:
 - The unit shall shut down and generate an alarm upon receiving an high static shutdown signal.
- Return Air Smoke Detection:
 - The unit shall shut down and generate an alarm upon receiving a return air smoke detector status.

- Supply Air Smoke Detection:
 - The unit shall shut down and generate an alarm upon receiving a supply air smoke detector status.
- Supply Fan:
 - The supply fan shall run anytime the unit is commanded to run, unless shutdown on safeties. To prevent short cycling, the supply fan shall have a user definable (adj.) minimum runtime.
 - Alarms shall be provided as follows:
 - Supply Fan Failure: Commanded on, but the status is off.
 - Supply Fan in Hand: Commanded off, but the status is on.
 - Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
- Supply Air Duct Static Pressure Control:
 - The controller shall measure duct static pressure and shall modulate the supply fan VFD speed to maintain a duct static pressure setpoint as determined by the balancer (adj.). The supply fan VFD speed shall not drop below 30% (adj.).
 - Alarms shall be provided as follows:
 - High Supply Air Static Pressure: If the supply air static pressure is 25% (adj.) greater than setpoint.
 - Low Supply Air Static Pressure: If the supply air static pressure is 25% (adj.) less than setpoint.
 - Supply Fan VFD Fault.
- Return Fan:
 - The return fan shall run whenever the supply fan runs.
 - Alarms shall be provided as follows:
 - Return Fan Failure: Commanded on, but the status is off.
 - Return Fan in Hand: Commanded off, but the status is on.
 - Return Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
 - Return Fan VFD Fault.
- Return Airflow:

- The return fan VFD shall modulate in unison with the supply fan VFD. Return airflow setpoint shall be 100% (adj.) of the supply airflow minus 580 cfm (adj.), at full system airflow, volume matching speed shall be determined by the balancer. The return fan VFD speed shall not drop below 20% (adj.).
- Supply Air Temperature Setpoint - Optimized:
 - The controller shall monitor the supply air temperature and shall maintain a supply air temperature setpoint reset based on zone cooling and heating requirements
 - The supply air temperature setpoint shall be reset for cooling based on zone cooling requirements as follows:
 - The initial supply air temperature setpoint shall be 55°F (adj.).
 - As cooling demand increases, the setpoint shall incrementally reset down to a minimum of 53°F (adj.).
 - As cooling demand decreases, the setpoint shall incrementally reset up to a maximum of 72°F (adj.).
 - If more zones need heating than cooling, then the supply air temperature setpoint shall be reset for heating as follows:
 - The initial supply air temperature setpoint shall be 82°F (adj.).
 - As heating demand increases, the setpoint shall incrementally reset up to a maximum of 85°F (adj.).
 - As heating demand decreases, the setpoint shall incrementally reset down to a minimum of 72°F (adj.).
- Cooling Stage:
 - The controller shall measure the supply air temperature and stage the cooling to maintain its cooling setpoint. To prevent short cycling, the stage shall have a user definable (adj.) minimum runtime.
- The cooling shall be enabled whenever:
 - Outside air temperature is greater than 60°F (adj.).
 - AND the economizer (if present) is disabled or fully open.
 - AND the supply fan status is on.
 - AND the heating (if present) is not active.
 - Alarms shall be provided as follows:
 - High Supply Air Temp: If the supply air temperature is 5°F (adj.) greater than setpoint.

- Low Supply Air Temperature Alarm: The controller shall alarm if the supply air temperature is less than 45°F (adj.).
- Economizer:
 - The controller shall measure the mixed air temperature and modulate the economizer dampers in sequence to maintain a setpoint 2°F (adj.) less than the supply air temperature setpoint. The outside air dampers shall maintain a minimum adjustable position of 20% (adj.) open whenever occupied.
 - The economizer shall be enabled whenever:
 - Outside air temperature is less than 65°F (adj.).
 - AND the outside air enthalpy is less than 22Btu/lb (adj.)
 - AND the outside air temperature is less than the return air temperature.
 - AND the outside air enthalpy is less than the return air enthalpy.
 - AND the supply fan status is on.
 - The economizer shall close whenever:
 - Mixed air temperature drops from 40°F to 35°F (adj.)
 - OR the freezestat (if present) is on.
 - OR on loss of supply fan status.
- ERV-1 shall be off and the outside and exhaust air dampers shall close and the return air damper shall open when the unit is off. If Optimal Start Up is available the mixed air damper shall operate as described in the occupied mode except that the outside air damper shall modulate to fully closed.
 - Minimum Outside Air Ventilation - Fixed Percentage:
 - The outside air dampers shall maintain a minimum adjustable position during building occupied hours and be closed during unoccupied hours.
- Filter Timer:
 - The controller shall monitor the filter timer.
 - Alarms shall be provided as follows:
 - Filter Change Required: Filter timer exceeds a user definable limit (adj.).
- Mixed Air Temperature:
 - The controller shall monitor the mixed air temperature and use as required for economizer control (if present) or preheating control (if present).
 - Alarms shall be provided as follows:

- High Mixed Air Temp: If the mixed air temperature is greater than 90°F (adj.).
- Low Mixed Air Temp: If the mixed air temperature is less than 45°F (adj.).
- Return Air Humidity:
 - The controller shall monitor the return air humidity and use as required for economizer control (if present) or humidity control (if present).
 - Alarms shall be provided as follows:
 - High Return Air Humidity: If the return air humidity is greater than 70% (adj.).
 - Low Return Air Humidity: If the return air humidity is less than 35% (adj.).
- Return Air Temperature:
 - The controller shall monitor the return air temperature and use as required for setpoint control or economizer control (if present).
 - Alarms shall be provided as follows:
 - High Return Air Temp: If the return air temperature is greater than 90°F (adj.).
 - Low Return Air Temp: If the return air temperature is less than 45°F (adj.).
- Supply Air Temperature:
 - The controller shall monitor the supply air temperature.
 - Alarms shall be provided as follows:
 - High Supply Air Temp: If the supply air temperature is greater than 120°F (adj.).
 - Low Supply Air Temp: If the supply air temperature is less than 45°F (adj.).

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
Mixed Air Temp	x								x		x
Prefilter Differential Pressure	x								x		
Return Air Humidity	x								x		x
Return Air Temp	x								x		x
Return Airflow	x								x		x
Supply Air Static Pressure	x								x	x	x
Supply Air Temp	x								x		x
Supply Airflow	x								x		x
Mixed Air Dampers		x							x		x

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
Return Fan VFD Speed		x							x		x
Supply Fan VFD Speed		x							x		x
High Static Shutdown			x						x	x	x
Return Air Smoke Detector			x						x	x	x
Return Fan Status			x						x		x
Return Fan VFD Fault			x							x	
Supply Air Smoke Detector			x						x	x	x
Supply Fan Status			x						x		x
Supply Fan VFD Fault			x							x	x
Cooling Stage 1				x					x		x
Return Fan Start/Stop				x					x		x
Supply Fan Start/Stop				x					x		x
Economizer Mixed Air Temp Setpoint					x				x		x
Return Airflow Setpoint					x				x		x
Supply Air Static Pressure Setpoint					x				x		x
Supply Air Temp Setpoint					x				x		x
Filter Timer					x				x	x	x
Compressor Runtime Exceeded										x	
High Mixed Air Temp										x	
High Return Air Humidity										x	
High Return Air Temp										x	
High Return Airflow										x	
High Supply Air Static Pressure										x	
High Supply Air Temp										x	
High Supply Air Temp										x	
Low Mixed Air Temp										x	
Low Return Air Humidity										x	
Low Return Air Temp										x	
Low Return Airflow										x	
Low Supply Air Static Pressure										x	
Low Supply Air Temp										x	
Low Supply Air Temp										x	
Filter Change Required										x	x

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
Return Fan Failure										x	
Return Fan in Hand										x	
Return Fan Runtime Exceeded										x	
Supply Fan Failure										x	
Supply Fan in Hand										x	
Supply Fan Runtime Exceeded										x	
Totals	8	3	7	3	5	0	0	0	24	30	26
Total Hardware (21)					Total Software (59)						

1.03 RTU-2 & RTU-3 Control (Typical 2)

- Run Conditions - Scheduled:
 - The unit shall run according to a user definable time schedule in the following modes:
 - Occupied Mode: The unit shall maintain:
 - A 75°F (adj.) cooling setpoint
 - A 70°F (adj.) heating setpoint.
 - Unoccupied Mode (night setback): The unit shall maintain:
 - A 85°F (adj.) cooling setpoint.
 - A 60°F (adj.) heating setpoint.
 - Alarms shall be provided as follows:
 - High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
 - Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).
- Zone Setpoint Adjust:
 - The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.
- Zone Optimal Start:
 - The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.
- Zone Unoccupied Override:

- A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.
- Emergency Shutdown:
 - The unit shall shut down and generate an alarm upon receiving an emergency shutdown signal.
- Return Air Smoke Detection:
 - The unit shall shut down and generate an alarm upon receiving a return air smoke detector status.
- Supply Air Smoke Detection:
 - The unit shall shut down and generate an alarm upon receiving a supply air smoke detector status.
- Supply Fan:
 - The supply fan shall run anytime the unit is commanded to run, unless shutdown on safeties. To prevent short cycling, the supply fan shall have a user definable (adj.) minimum runtime.
 - Alarms shall be provided as follows:
 - Supply Fan Failure: Commanded on, but the status is off.
 - Supply Fan in Hand: Commanded off, but the status is on.
 - Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
- Return Fan:
 - The return fan shall run whenever the supply fan runs.
 - Alarms shall be provided as follows:
 - Return Fan Failure: Commanded on, but the status is off.
 - Return Fan in Hand: Commanded off, but the status is on.
 - Return Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
- Heat Recovery Wheel - Variable Speed:
 - The controller shall modulate the heat recovery wheel for energy recovery as follows.
 - Cooling Recovery Mode:

- The controller shall measure the zone temperature and modulate the heat wheel speed to maintain a setpoint 2°F (adj.) less than the zone cooling setpoint. The heat wheel shall run for cool recovery whenever:
 - Return air temperature is 5°F (adj.) or more below the outside air temperature.
 - AND the zone temperature is above cooling setpoint.
 - AND the economizer (if present) is off.
 - AND the supply fan is on.
- Heating Recovery Mode:
 - The controller shall measure the zone temperature and modulate the heat wheel speed to maintain a setpoint 2°F (adj.) greater than the zone heating setpoint. The heat wheel shall run for heat recovery whenever:
 - Return air temperature is 5°F (adj.) or more above the outside air temperature.
 - AND the zone temperature is below heating setpoint.
 - AND the economizer (if present) is off.
 - AND the supply fan is on.
- Periodic Self-Cleaning:
 - The heat wheel shall run at 5% speed (adj.) for 10sec (adj.) every 4hr (adj.) the unit runs.
- Frost Protection:
 - The heat wheel shall run at 5% speed (adj.) whenever:
 - Outside air temperature drops below 15°F (adj.)
 - OR the exhaust air temperature drops below 20°F (adj.).
 - The heat wheel bypass dampers will open whenever the heat wheel is disabled.
- Alarms shall be provided as follows:
 - Heat Wheel Rotation Failure: Commanded on, but the status is off.
 - Heat Wheel in Hand: Commanded off, but the status is on.
 - Heat Wheel Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
 - Heat Wheel VFD Fault
- Cooling Stage:

- The controller shall measure the zone temperature and stage the cooling to maintain its cooling setpoint. To prevent short cycling, the stage shall have a user definable (adj.) minimum runtime.
- The cooling shall be enabled whenever:
 - Outside air temperature is greater than 60°F (adj.).
 - AND the economizer (if present) is disabled or fully open.
 - AND the zone temperature is above cooling setpoint.
 - AND the supply fan status is on.
 - AND the heating is not active.
- Gas Heating Stage:
 - The controller shall measure the zone temperature and stage the heating to maintain its heating setpoint. To prevent short cycling, the stage shall have a user definable (adj.) minimum runtime.
 - The heating shall be enabled whenever:
 - Outside air temperature is less than 65°F (adj.).
 - AND the zone temperature is below heating setpoint.
 - AND the supply fan status is on.
 - AND the cooling is not active.
- Economizer:
 - The controller shall measure the zone temperature and modulate the economizer dampers in sequence to maintain a setpoint 2°F less than the zone cooling setpoint. The outside air dampers shall maintain a minimum adjustable position of 20% (adj.) open whenever occupied.
 - The economizer shall be enabled whenever:
 - Outside air temperature is less than 65°F (adj.).
 - AND the outside air enthalpy is less than 22Btu/lb (adj.).
 - AND the outside air temperature is less than the return air temperature.
 - AND the outside air enthalpy is less than the return air enthalpy.
 - AND the supply fan status is on.
 - The economizer shall close whenever:
 - Mixed air temperature drops from 45°F to 40°F (adj.).

- OR on loss of supply fan status.
 - OR freezestat (if present) is on.
- The outside and exhaust air dampers shall close and the return air damper shall open when the unit is off. If Optimal Start Up is available, the mixed air damper shall operate as described in the occupied mode except that the outside air damper shall modulate to fully closed.
- Minimum Outside Air Ventilation - Carbon Dioxide (CO₂) Control (RTU-03 only):
 - When in the occupied mode, the controller shall measure the return air CO₂ levels and modulate the outside air dampers open on rising CO₂ concentrations, overriding normal damper operation to maintain a CO₂ setpoint of 750 ppm (adj.).
- Dehumidification:
 - The controller shall measure the return air humidity and override the cooling sequence to maintain return air humidity at or below 60% rh (adj.).
 - During dehumidification, the heating shall modulate to maintain a setpoint 1°F (adj.) less than the zone cooling setpoint.
 - Dehumidification shall be enabled whenever:
 - the supply fan status is on.
 - AND zone temperature is greater than the cooling setpoint.
- Filter Timer:
 - The controller shall monitor the filter timer.
 - Alarms shall be provided as follows:
 - Filter Change Required: Filter timer exceeds a user definable limit (adj.).
- Mixed Air Temperature:
 - The controller shall monitor the mixed air temperature and use as required for economizer control (if present) or preheating control (if present).
 - Alarms shall be provided as follows:
 - High Mixed Air Temp: If the mixed air temperature is greater than 90°F (adj.).
 - Low Mixed Air Temp: If the mixed air temperature is less than 45°F (adj.).
- Return Air Carbon Dioxide (CO₂) Concentration Monitoring (RTU-03 Only):
 - The controller shall measure the return air CO₂ concentration.
 - Alarms shall be provided as follows:

- High Return Air Carbon Dioxide Concentration: If the return air CO2 concentration is greater than 1000ppm (adj.) when in the occupied mode.
- Return Air Humidity:
 - The controller shall monitor the return air humidity and use as required for economizer control (if present) or humidity control (if present).
 - Alarms shall be provided as follows:
 - High Return Air Humidity: If the return air humidity is greater than 70% (adj.).
 - Low Return Air Humidity: If the return air humidity is less than 35% (adj.).
- Return Air Temperature:
 - The controller shall monitor the return air temperature and use as required for economizer control (if present).
 - Alarms shall be provided as follows:
 - High Return Air Temp: If the return air temperature is greater than 90°F (adj.).
 - Low Return Air Temp: If the return air temperature is less than 45°F (adj.).
- Supply Air Temperature:
 - The controller shall monitor the supply air temperature.
 - Alarms shall be provided as follows:
 - High Supply Air Temp: If the supply air temperature is greater than 120°F (adj.).
 - Low Supply Air Temp: If the supply air temperature is less than 45°F (adj.).

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
Exhaust Air Temp	x								x		x
Heat Wheel Discharge Air Temp	x								x		x
Mixed Air Temp	x								x		x
Outside Air Humidity	x								x		x
Outside Air Temp	x								x		x
Outside Air Temp	x								x		x
Return Air Carbon Dioxide PPM	x								x		x
Return Air Humidity	x								x		x
Return Air Temp	x								x		x
Supply Air Temp	x								x		x

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
Zone Setpoint Adjust	x										x
Zone Temp	x								x		x
Heat Wheel VFD Speed		x							x		x
Mixed Air Dampers		x							x		x
Heat Wheel Status			x						x		x
Heat Wheel VFD Fault			x						x	x	x
Return Air Smoke Detector			x						x	x	x
Return Fan Status			x						x		x
Supply Air Smoke Detector			x						x	x	x
Supply Fan Status			x						x		x
Zone Override			x						x		x
Cooling Stage 1				x					x		x
Heat Wheel Bypass Dampers				x					x		x
Heat Wheel Start/Stop				x					x		x
Heating Stage 1				x					x		x
Return Fan Start/Stop				x					x		x
Supply Fan Start/Stop				x					x		x
Cooling Setpoint					x				x		x
Dehumidification Setpoint					x				x		x
Economizer Zone Temp Setpoint					x				x		x
Heating Setpoint					x				x		x
Return Air Carbon Dioxide PPM Setpoint					x				x		x
Filter Timer					x				x	x	x
Emergency Shutdown						x				x	x
Schedule								x			
Compressor Runtime Exceeded										x	
Heat Wheel in Hand										x	
Heat Wheel Rotation Failure										x	
Heat Wheel Runtime Exceeded										x	
High Mixed Air Temp										x	
High Return Air Carbon Dioxide Concentration										x	
High Return Air Humidity										x	
High Return Air Temp										x	

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
High Supply Air Temp										x	
High Zone Temp										x	
Low Mixed Air Temp										x	
Low Return Air Humidity										x	
Low Return Air Temp										x	
Low Supply Air Temp										x	
Low Zone Temp										x	
Filter Change Required										x	x
Return Fan Failure										x	
Return Fan in Hand										x	
Return Fan Runtime Exceeded										x	
Supply Fan Failure										x	
Supply Fan in Hand										x	
Supply Fan Runtime Exceeded										x	
Totals	12	2	7	6	6	1	0	1	32	27	35

Total Hardware (27)

Total Software (67)

1.04 RTU-4 Control (Typical 1) (Base-Bid #2)

- Run Conditions - Requested:
 - The unit shall run whenever:
 - Any zone is occupied.
 - OR a definable number of unoccupied zones need heating or cooling.
- High Static Shutdown:
 - The unit shall shut down and generate an alarm upon receiving an high static shutdown signal.
- Return Air Smoke Detection:
 - The unit shall shut down and generate an alarm upon receiving a return air smoke detector status.
- Supply Air Smoke Detection:
 - The unit shall shut down and generate an alarm upon receiving a supply air smoke detector status.
- Supply Fan:
 - The supply fan shall run anytime the unit is commanded to run, unless shutdown on safeties. To prevent short cycling, the supply fan shall have a user definable (adj.) minimum runtime.
 - Alarms shall be provided as follows:
 - Supply Fan Failure: Commanded on, but the status is off.
 - Supply Fan in Hand: Commanded off, but the status is on.
 - Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
- Supply Air Duct Static Pressure Control:
 - The controller shall measure duct static pressure and shall modulate the supply fan VFD speed to maintain a duct static pressure setpoint as determined by the balancer (adj.). The supply fan VFD speed shall not drop below 30% (adj.).
 - Alarms shall be provided as follows:
 - High Supply Air Static Pressure: If the supply air static pressure is 25% (adj.) greater than setpoint.

- Low Supply Air Static Pressure: If the supply air static pressure is 25% (adj.) less than setpoint.
 - Supply Fan VFD Fault.
- Return Fan:
 - The return fan shall run whenever the supply fan runs.
 - Alarms shall be provided as follows:
 - Return Fan Failure: Commanded on, but the status is off.
 - Return Fan in Hand: Commanded off, but the status is on.
 - Return Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
 - Return Fan VFD Fault.
- Return Airflow:
 - The return fan VFD shall modulate in unison with the supply fan VFD. Return airflow setpoint shall be 100% (adj.) of the supply airflow minus 100 cfm (adj.), at full system airflow, volume matching speed shall be determined by the balancer. The return fan VFD speed shall not drop below 20% (adj.).
- Heat Recovery Wheel - Variable Speed:
 - The controller shall modulate the heat recovery wheel for energy recovery as follows.
 - Cooling Recovery Mode:
 - The controller shall measure the heat wheel discharge air temperature and modulate the heat wheel speed to maintain a setpoint 2°F (adj.) less than the unit supply air temperature setpoint. The heat wheel shall run for cool recovery whenever:
 - The unit return air temperature is 5°F (adj.) or more below the outside air temperature.
 - AND the unit is in a cooling mode.
 - AND the economizer (if present) is off.
 - AND the supply fan is on.
 - Heating Recovery Mode:
 - The controller shall measure the heat wheel discharge air temperature and modulate the heat wheel speed to maintain a setpoint 2°F (adj.) greater than the unit supply air temperature setpoint. The heat wheel shall run for heat recovery whenever:

- The unit return air temperature is 5°F (adj.) or more above the outside air temperature.
 - AND the unit is in a heating mode.
 - AND the economizer (if present) is off.
 - AND the supply fan is on.
- Periodic Self-Cleaning:
 - The heat wheel shall run at 5% speed (adj.) for 10sec (adj.) every 4hr (adj.) the unit runs.
- Frost Protection:
 - The heat wheel shall run at 5% speed (adj.) whenever:
 - Outside air temperature drops below 15°F (adj.)
 - OR the exhaust air temperature drops below 20°F (adj.).
- The heat wheel bypass dampers will open whenever the heat wheel is disabled.
- Alarms shall be provided as follows:
 - Heat Wheel Rotation Failure: Commanded on, but the status is off.
 - Heat Wheel in Hand: Commanded off, but the status is on.
 - Heat Wheel Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
 - Heat Wheel VFD Fault
- Supply Air Temperature Setpoint - Optimized:
 - The controller shall monitor the supply air temperature and shall maintain a supply air temperature setpoint reset based on zone cooling and heating requirements
 - The supply air temperature setpoint shall be reset for cooling based on zone cooling requirements as follows:
 - The initial supply air temperature setpoint shall be 55°F (adj.).
 - As cooling demand increases, the setpoint shall incrementally reset down to a minimum of 53°F (adj.).
 - As cooling demand decreases, the setpoint shall incrementally reset up to a maximum of 72°F (adj.) .
 - If more zones need heating than cooling, then the supply air temperature setpoint shall be reset for heating as follows:
 - The initial supply air temperature setpoint shall be 82°F (adj.).

- As heating demand increases, the setpoint shall incrementally reset up to a maximum of 85°F (adj.).
 - As heating demand decreases, the setpoint shall incrementally reset down to a minimum of 72°F (adj.).
- Cooling Stage:
 - The controller shall measure the supply air temperature and stage the cooling to maintain its cooling setpoint. To prevent short cycling, the stage shall have a user definable (adj.) minimum runtime.
 - The cooling shall be enabled whenever:
 - Outside air temperature is greater than 60°F (adj.).
 - AND the economizer (if present) is disabled or fully open.
 - AND the supply fan status is on.
 - AND the heating (if present) is not active.
 - Alarms shall be provided as follows:
 - High Supply Air Temp: If the supply air temperature is 5°F (adj.) greater than setpoint.
- Gas Heating Stage:
 - The controller shall measure the supply air temperature and stage the heating to maintain its heating setpoint. To prevent short cycling, the stage shall have a user definable (adj.) minimum runtime.
 - The heating shall be enabled whenever:
 - Outside air temperature is less than 65°F (adj.).
 - AND the supply fan status is on.
 - AND the cooling (if present) is not active.
 - The heating stage shall run for freeze protection whenever:
 - Supply air temperature drops from 40°F to 35°F (adj.).
 - AND the supply fan status is on.
 - Alarms shall be provided as follows:
 - Low Supply Air Temp: If the supply air temperature is 5°F (adj.) less than setpoint.
- Economizer:

- The controller shall measure the mixed air temperature and modulate the economizer dampers in sequence to maintain a setpoint 2°F (adj.) less than the supply air temperature setpoint. The outside air dampers shall maintain a minimum adjustable position of 20% (adj.) open whenever occupied.
- The economizer shall be enabled whenever:
 - Outside air temperature is less than 65°F (adj.).
 - AND the outside air temperature is less than the return air temperature.
 - AND the supply fan status is on.
- The economizer shall close whenever:
 - Mixed air temperature drops from 40°F to 35°F (adj.).
 - OR the freezestat (if present) is on.
 - OR on loss of supply fan status.
- The outside and exhaust air dampers shall close and the return air damper shall open when the unit is off. If Optimal Start Up is available the mixed air damper shall operate as described in the occupied mode except that the outside air damper shall modulate to fully closed.
- Minimum Outside Air Ventilation - Fixed Percentage:
 - The outside air dampers shall maintain a minimum adjustable position during building occupied hours and be closed during unoccupied hours.
- Filter Timer:
 - The controller shall monitor the filter timer.
 - Alarms shall be provided as follows:
 - Filter Change Required: Filter timer exceeds a user definable limit (adj.).
- Mixed Air Temperature:
 - The controller shall monitor the mixed air temperature and use as required for economizer control (if present) or preheating control (if present).
 - Alarms shall be provided as follows:
 - High Mixed Air Temp: If the mixed air temperature is greater than 90°F (adj.).
 - Low Mixed Air Temp: If the mixed air temperature is less than 45°F (adj.).
- Return Air Humidity:
 - The controller shall monitor the return air humidity and use as required for economizer control (if present) or humidity control (if present).

- Alarms shall be provided as follows:
 - High Return Air Humidity: If the return air humidity is greater than 70% (adj.).
 - Low Return Air Humidity: If the return air humidity is less than 35% (adj.).
- Return Air Temperature:
 - The controller shall monitor the return air temperature and use as required for setpoint control or economizer control (if present).
 - Alarms shall be provided as follows:
 - High Return Air Temp: If the return air temperature is greater than 90°F (adj.).
 - Low Return Air Temp: If the return air temperature is less than 45°F (adj.).
- Supply Air Temperature:
 - The controller shall monitor the supply air temperature.
 - Alarms shall be provided as follows:
 - High Supply Air Temp: If the supply air temperature is greater than 120°F (adj.).
 - Low Supply Air Temp: If the supply air temperature is less than 45°F (adj.).

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
Exhaust Air Temp	x								x		x
Heat Wheel Discharge Air Temp	x								x		x
Mixed Air Temp	x								x		x
Outside Air Temp	x								x		x
Return Air Humidity	x								x		x
Return Air Temp	x								x		x
Return Airflow	x								x		x
Supply Air Static Pressure	x								x	x	x
Supply Air Temp	x								x		x
Supply Airflow	x								x		x
Heat Wheel VFD Speed		x							x		x
Mixed Air Dampers		x							x		x
Return Fan VFD Speed		x							x		x
Supply Fan VFD Speed		x							x		x
Heat Wheel Status			x						x		x
Heat Wheel VFD Fault			x						x	x	x

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
High Static Shutdown			x						x	x	x
Return Air Smoke Detector			x						x	x	x
Return Fan Status			x						x		x
Return Fan VFD Fault			x							x	
Supply Air Smoke Detector			x						x	x	x
Supply Fan Status			x						x		x
Supply Fan VFD Fault			x							x	x
Cooling Stage 1				x					x		x
Heat Wheel Bypass Dampers				x					x		x
Heat Wheel Start/Stop				x					x		x
Heating Stage 1				x					x		x
Return Fan Start/Stop				x					x		x
Supply Fan Start/Stop				x					x		x
Economizer Mixed Air Temp Setpoint					x				x		x
Return Airflow Setpoint					x				x		x
Supply Air Static Pressure Setpoint					x				x		x
Supply Air Temp Setpoint					x				x		x
Filter Timer					x				x	x	x
Compressor Runtime Exceeded										x	
Heat Wheel in Hand										x	
Heat Wheel Rotation Failure										x	
Heat Wheel Runtime Exceeded										x	
High Mixed Air Temp										x	
High Return Air Humidity										x	
High Return Air Temp										x	
High Return Airflow										x	
High Supply Air Static Pressure										x	
High Supply Air Temp										x	
High Supply Air Temp										x	
Low Mixed Air Temp										x	
Low Return Air Humidity										x	
Low Return Air Temp										x	
Low Return Airflow										x	

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
Low Supply Air Static Pressure										x	
Low Supply Air Temp										x	
Low Supply Air Temp										x	
Return Fan Failure										x	
Return Fan in Hand										x	
Return Fan Runtime Exceeded										x	
Supply Fan Failure										x	
Supply Fan in Hand										x	
Supply Fan Runtime Exceeded										x	
Totals	10	4	9	6	5	0	0		32	32	36

Total Hardware (29)

Total Software (69)

1.05 ERV-1 Control

- Run Conditions – Scheduled
 - The fans shall run as scheduled interlocked to RTU-01 (adj.).
- Exhaust air Fan
 - The exhaust air fan shall have a user definable (adj.) schedule to coincide with the corresponding RTU occupied cycle.
- Fresh air Fan
 - The fresh air fan shall have a user definable (adj.) schedule to coincide with the corresponding AHU occupied cycle. During occupied cycles when the economizer cycle on the AHU is active, the fresh air fan shall be OFF, and the fresh air damper on the corresponding AHU shall be closed.
- Fan Status
 - The controller shall monitor the status of the fans.
- Alarms shall be provided as follows:
 - Fan(s) Failure: Commanded on, but the status is off.
 - Fan(s) in Hand: Commanded off, but the status is on.
 - Fan(s) Runtime Exceeded: Fan status runtime exceeds a user definable limit (adj.).
 - Fan(s) VFD Fault
 - Filter(s) Change Req'd.: Filter(s) timer(s) exceeds a user definable limit (adj.).

- Core(s) Cleaning Req'd.: Core differential pressure(s) exceeds a user definable limit (adj.)

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
Fresh Air Temp.	x								x		x
Exhaust Air Temp.	x								x		x
Outside Air Temp.	x								x		x
Return Air Temp.	x								x		x
Outside Air Humid.	x								x		x
Return Air Humid.	x								x		x
Fresh Air Core Diff. Pressure	x								x		
Exhaust Air Core Diff. Pressure	x								x		
Fresh Air Damper		x									x
Exhaust Air Damper		x									x
Fresh Air Fan Status			x						x		x
Fresh Air Fan VFD Fault			x							x	x
Exhaust Air Fan Status			x						x		x
Exhaust Air Fan VFD Fault			x							x	x
Fresh Air Fan Start/Stop				x					x		x
Exhaust Air Fan Start/Stop				x					x		x
Fresh Airflow					x				x		x
Exhaust Airflow					x				x		x
Filter Timer					x				x	x	x
Fresh Air Fan VFD Speed									x		x
Exhaust Air Fan VFD Speed									x		x
Outside Air Filter Change Req'd										x	x
Return Air Filter Change Req'd										x	x
Exhaust Air Core Cleaning Req'd										x	x
Fresh Air Core Cleaning Req'd										x	x
Fresh Air Fan Failure										x	
Fresh Air Fan in Hand										x	
Fresh Fan Runtime Exceeded										x	
Exhaust Air Fan Failure										x	
Exhaust Air Fan in Hand										x	
Exhaust Fan Runtime Exceeded										x	
Totals	8	2	4	2	3	0	0	0	17	13	22

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
Total Hardware (16)					Total Software (33)						

1.06 TYPICAL VAV CONTROL (typical of 12)

Run Conditions - Scheduled:

The unit shall run according to a user definable time schedule in the following modes:

- Occupied Mode: The unit shall maintain
 - A 75°F (adj.) cooling setpoint
 - A 70°F (adj.) heating setpoint.
- Unoccupied Mode (night setback): The unit shall maintain
 - A 85°F (adj.) cooling setpoint.
 - A 55°F (adj.) heating setpoint.

Alarms shall be provided as follows:

- High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
- Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).

Zone Setpoint Adjust:

The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.

Zone Unoccupied Override:

A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.

Reversing Variable Volume Terminal Unit - Flow Control:

The unit shall maintain zone setpoints by controlling the airflow through one of the following:

Occupied:

- When zone temperature is greater than its cooling setpoint, the zone damper shall modulate between the minimum occupied airflow (adj.) and the maximum cooling airflow (adj.) until the zone is satisfied.
- When the zone temperature is between the cooling setpoint and the heating setpoint, the zone damper shall maintain the minimum required zone ventilation (adj.).
- When zone temperature is less than its heating setpoint, the controller shall enable heating to maintain the zone temperature at its heating setpoint. Additionally, if warm air is available from the AHU, the zone damper shall modulate between the minimum occupied airflow (adj.) and the maximum heating airflow (adj.) until the zone is satisfied.

Unoccupied:

- When the zone is unoccupied the zone damper shall control to its minimum unoccupied airflow (adj.).

- When the zone temperature is greater than its cooling setpoint, the zone damper shall modulate between the minimum unoccupied airflow (adj.) and the maximum cooling airflow (adj.) until the zone is satisfied.
- When zone temperature is less than its unoccupied heating setpoint, the controller shall enable heating to maintain the zone temperature at the setpoint. Additionally, if warm air is available from the AHU, the zone damper shall modulate between the minimum unoccupied airflow (adj.) and the auxiliary heating airflow (adj.) until the zone is satisfied.

Reheating Coil Valve:

The controller shall measure the zone temperature and modulate the reheating coil valve open on dropping temperature to maintain its heating setpoint.

The zone damper shall modulate to the minimum occupied airflow (adj.). If more heat is required, the zone damper shall modulate to the auxiliary heating airflow (adj.).

Reheating - High Discharge Air Temperature Limit:

The controller shall measure the discharge air temperature and limit reheating if the discharge air temperature is more than 95°F (adj.).

Discharge Air Temperature:

The controller shall monitor the discharge air temperature.

Alarms shall be provided as follows:

- High Discharge Air Temp: If the discharge air temperature is greater than 120°F (adj.).
- Low Discharge Air Temp: If the discharge air temperature is less than 40°F (adj.).

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
Airflow	x								x		x
Discharge Air Temp	x								x		x
Zone Setpoint Adjust	x										x
Zone Temp	x								x		x
Reheating Valve		x							x		x
Zone Damper		x							x		x
Zone Override			x						x		x
Airflow Setpoint					x				x		x
Cooling Setpoint					x				x		x
DAT Heating Limit					x						
Heating Setpoint					x				x		x
Heating Mode						x			x		
Schedule								x			
High Discharge Air Temp										x	
High Zone Temp										x	
Low Discharge Air Temp										x	

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
Low Zone Temp										x	
Totals	4	2	1	0	4	1	0	1	10	4	10
Total Hardware (7)					Total Software (20)						

1.07 Unit Heater Control (Typical 4)

Run Conditions - Continuous:

The unit shall run continuously and shall maintain a heating setpoint of 70°F (adj.).

Alarms shall be provided as follows:

- Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).

Fan:

The fan shall run anytime the zone temperature drops below heating setpoint, unless shutdown on safeties.

Heating Coil Valve:

The controller shall measure the zone temperature and modulate the heating coil valve to maintain its heating setpoint.

The heating shall be enabled whenever:

- Outside air temperature is less than 65°F (adj.).
- AND the zone temperature is below heating setpoint.
- AND the fan is on.

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
Zone Temp	x								x		x
Heating Valve		x							x		x
Fan Start/Stop				x					x		x
Heating Setpoint					x				x		x
Low Zone Temp										x	
Totals	1	1	0	1	1	0	0	0	4	1	4
Total Hardware (3)					Total Software (6)						

1.08 Mini-Split Control (Typical 1)

Run Conditions - Continuous:

The unit shall run continuously and shall maintain:

- A 75°F (adj.) cooling setpoint.
- A 70°F (adj.) heating setpoint.

The Mini-Split system shall run subject to its own internal safeties and controls. BAS shall monitor all Mini-Split operation parameters available via BACnet.

Alarms shall be provided as follows:

- High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
- Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).

Zone Setpoint Adjust:

The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.

Fan:

The fan shall run anytime the unit is commanded to run, unless shutdown on safeties.

Cooling Stage:

The controller shall measure the zone temperature and stage the cooling to maintain its cooling setpoint. To prevent short cycling, the stage shall have a user definable (adj.) minimum runtime.

The cooling shall be enabled whenever:

- Outside air temperature is greater than 60°F (adj.).
- AND the zone temperature is above cooling setpoint.
- AND the fan is on.

Fan Status:

The controller shall monitor the fan status.

Alarms shall be provided as follows:

- Fan Failure: Commanded on, but the status is off.
- Fan in Hand: Commanded off, but the status is on.
- Fan Runtime Exceeded: Fan status runtime exceeds a user definable limit (adj.).

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
Zone Setpoint Adjust	x										x
Zone Temp	x								x		x
Fan Status			x								x
Cooling Stage 1				x					x		x
Fan Start/Stop				x					x		x
Cooling Setpoint					x				x		x

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
Heating Setpoint					x				x		x
Compressor Runtime Exceeded										x	
Fan Failure										x	
Fan in Hand										x	
Fan Runtime Exceeded										x	
High Zone Temp										x	
Low Zone Temp										x	
Totals	2	0	1	2	2	0	0	0	5	7	7
Total Hardware (5)					Total Software (14)						

1.09 Heating Hot Water Boiler Control (Typical 1)

Boiler System Run Conditions:

The boiler system shall be enabled to run whenever:

- A definable number of hot water coils need heating.
- AND outside air temperature is less than 65°F (adj.).

To prevent short cycling, the boiler system shall run for and be off for minimum adjustable times (both user definable), unless shutdown on safeties or outside air conditions.

The boiler shall run subject to its own internal safeties and controls. BAS shall monitor all Boiler operation parameters available via BACnet.

The boiler system shall also run for freeze protection whenever outside air temperature is less than 38°F (adj.).

Boiler Safeties:

The following safeties shall be monitored:

- Boiler alarm.
- Low Water Level.

Alarms shall be provided as follows:

- Boiler alarm.
- Low Water Level alarm.

Hot Water Pump Lead/Standby Operation:

The two hot water pumps shall operate in a lead/standby fashion.

- The lead pump shall run first.

- On failure of the lead pump, the standby pump shall run and the lead pump shall turn off.
- On decreasing hot water differential pressure, the lag pump shall stage on and run in unison with the lead pump to maintain hot water differential pressure setpoint.

The designated lead pump shall rotate upon one of the following conditions (user selectable):

- manually through a software switch
- if pump runtime (adj.) is exceeded
- daily
- weekly
- monthly

Alarms shall be provided as follows:

- Hot Water Pump 1
 - Failure: Commanded on, but the status is off.
 - Running in Hand: Commanded off, but the status is on.
 - Runtime Exceeded: Status runtime exceeds a user definable limit.
- Hot Water Pump 2
 - Failure: Commanded on, but the status is off.
 - Running in Hand: Commanded off, but the status is on.
 - Runtime Exceeded: Status runtime exceeds a user definable limit.

Hot Water Differential Pressure Control:

The controller shall measure hot water differential pressure and modulate the hot water pump VFDs in sequence to maintain its hot water differential pressure setpoint.

The following setpoints are recommended values. All setpoints shall be field adjusted during the commissioning period to meet the requirements of actual field conditions.

The controller shall modulate hot water pump speeds to maintain a hot water differential pressure of 12 lb_f/in² (adj.). The VFDs minimum speed shall not drop below 20% (adj.).

On dropping hot water differential pressure, the VFDs shall stage on and run to maintain setpoint as follows:

- The controller shall modulate the lead VFD to maintain setpoint.
- If the lead VFD speed is greater than a setpoint of 90% (adj.), the lag VFD shall stage on.
- The lag VFD shall ramp up to match the lead VFD speed and then run in unison with the lead VFD to maintain setpoint.

On rising hot water differential pressure, the VFDs shall stage off as follows:

- If the VFDs speeds drops back to 60% (adj.) below setpoint, the lag VFD shall stage off.

- The lead VFD shall continue to run to maintain setpoint.

Alarms shall be provided as follows:

- High Hot Water Differential Pressure: If 25% (adj.) greater than setpoint.
- Low Hot Water Differential Pressure: If 25% (adj.) less than setpoint.

Circulation Pump:

The circulation pump shall run anytime the boiler is called to run and shall have a user definable (adj.) delay on stop.

Alarms shall be provided as follows:

- Circulation Pump Failure: Commanded on, but the status is off.
- Circulation Pump Running in Hand: Commanded off, but the status is on.
- Circulation Pump Runtime Exceeded: Status runtime exceeds a user definable limit.

Boiler Enable:

The boiler shall be enabled when the boiler system is commanded on. The boiler shall be enabled after pump status is proven on and shall run subject to its own internal safeties and controls.

Alarms shall be provided as follows:

- Boiler Failure: Commanded on, but the status is off.
- Boiler Running in Hand: Commanded off, but the status is on.
- Boiler Runtime Exceeded: Status runtime exceeds a user definable limit.

Hot Water Supply Temperature Setpoint Reset:

The hot water supply temperature setpoint shall reset based on outside air temperature or heating requests.

As outside air temperature rises from 0°F (adj.) to 70°F (adj.) the hot water supply temperature setpoint shall reset downwards by subtracting from 0°F (adj.) up to 20°F (adj.) from the current boiler setpoint.

Primary Hot Water Temperature Monitoring:

The following temperatures shall be monitored:

- Primary hot water supply.
- Primary hot water return.

Alarms shall be provided as follows:

- High Primary Hot Water Supply Temp: If greater than 200°F (adj.).
- Low Primary Hot Water Supply Temp: If less than 100°F (adj.).

Hardware Points	Software Points
------------------------	------------------------

Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
Primary Hot Water Diff. Press.	x								x		x
Primary Hot Water Return Temp	x								x		x
Primary Hot Water Supply Temp	x								x		x
HHWS Temp Setpoint Reset		x							x		x
Boiler Alarm Status			x						x	x	x
Boiler Status			x						x		x
Circulation Pump Status			x						x		x
Hot Water Pump 1 Status			x						x		x
Hot Water Pump 2 Status			x						x		x
Low Water Level			x						x	x	x
Boiler Enable				x							x
Circulation Pump Start/Stop				x					x		x
Hot Water Pump 1 Start/Stop				x							x
Hot Water Pump 2 Start/Stop				x							x
Outside Air Temp					x						x
Boiler Failure										x	
Boiler Running in Hand										x	
Boiler Runtime Exceeded										x	
Circ. Pump Failure										x	
Circ. Pump Running in Hand										x	
Circ. Pump Runtime Exceeded										x	
High Primary Hot Water Supply Temp										x	
Hot Water Pump 1 Failure										x	
Hot Water Pump 1 Running in Hand										x	
Hot Water Pump 1 Runtime Exceeded										x	
Hot Water Pump 2 Failure										x	
Hot Water Pump 2 Running in Hand										x	
Hot Water Pump 2 Runtime Exceeded										x	
Low Primary Hot Water Supply Temp										x	
Totals	3	1	6	4	1	0	0	0	11	16	15

Total Hardware (14)

Total Software (28)

1.10 Water Heater Interface (Typical 1)

Water Heater status and operating conditions will be monitored through its communications interface port. The interface port will monitor and trend all the points available from the unit.

1.11 DCW Meter (Typical 1)

The controller shall monitor the water meter for water consumption on a continual basis. These values shall be made available to the system at all times.

Alarm shall be generated as follows:

- Meter Failure: Sensor reading indicates a loss of pulse output from the water meter.

Peak Demand History:

The controller shall monitor and record the peak (high and low) demand readings from the water meter. These readings shall be recorded on a daily, month-to-date, and year-to-date basis.

Usage History:

The controller shall monitor and record water meter readings so as to provide a water consumption history.

Usage readings shall be recorded on a daily, month-to-date, and year-to-date basis.

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
Water Flow Rate	x										
Demand									x		x
Peak Month-to-Date									x		x
Peak Today									x		x
Peak Year-to-Date									x		x
Usage Month-to-Date									x		x
Usage Today									x		x
Usage Year-to-Date									x		x
Meter Failure										x	
Totals	1	0	0	0	0	0	0	0	7	1	7

Total Hardware (1)

Total Software (8)

1.12 NG Meter (Typical 1)

The controller shall monitor the gas meter for gas consumption on a continual basis. These values shall be made available to the system at all times.

Alarm shall be generated as follows:

- Meter Failure: Sensor reading indicates a loss of pulse output from the gas meter.

Peak Demand History:

The controller shall monitor and record the peak (high and low) demand readings from the gas meter. Peak readings shall be recorded on a daily, month-to-date, and year-to-date basis.

Usage History:

The controller shall monitor and record gas meter readings so as to provide a gas consumption history. Usage readings shall be recorded on a daily, month-to-date, and year-to-date basis.

	Hardware Points				Software Points						
Point Name	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	Show On Graphic
Gas Flow Rate	x										
Demand									x		x
Peak Month-to-Date									x		x
Peak Today									x		x
Peak Year-to-Date									x		x
Usage Month-to-Date									x		x
Usage Today									x		x
Usage Year-to-Date									x		x
Meter Failure										x	
Totals	1	0	0	0	0	0	0	0	7	1	7

Total Hardware (1)

Total Software (8)

1.13 Electric Meter (Typical 1)

The controller shall monitor the electric meter for electric consumption on a continual basis. These values shall be made available to the system at all times.

Alarm shall be generated as follows:

- Meter Failure: Sensor reading indicates a loss of pulse output from the electric meter.

Peak Demand History:

The controller shall monitor and record the peak (high and low) demand readings from the electric meter. Peak readings shall be recorded on a daily, month-to-date, and year-to-date basis.

Usage History:

The controller shall monitor and record electric meter readings so as to provide a power consumption history. Usage readings shall be recorded on a daily, month-to-date, and year-to-date basis.

Demand Levels:

The controller shall set the system demand level (adj.) based on the current power consumption readings from

the electric meter. There shall be six daily time periods in which the demand shall be adjusted on three levels. These demand levels shall be available for facility equipment to utilize for demand limiting.

- Demand Level 1: Power consumption has exceeded the first demand level threshold (adj.).
- Demand Level 2: Power consumption has exceeded the second demand level threshold (adj.).
- Demand Level 3: Power consumption has exceeded the third demand level threshold (adj.).

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
kW Pulse	x										x
Current Demand Level					x				x		x
kW Demand									x		x
kW Peak Month-to-Date									x		x
kW Peak Today									x		x
kW Peak Year-to-Date									x		x
kWh Today									x		x
MWh Month-to-Date									x		x
MWh Year-to-Date									x		x
Demand Level 1										x	
Demand Level 2										x	
Demand Level 3										x	
Meter Failure										x	
Totals	1	0	0	0	1	0	0	0	8	4	9

Total Hardware (1)

Total Software (13)

1.14 Outside Air Conditions Building Controls (Typical 1)

The controller shall monitor the outside air temperature and humidity and calculate the outside air enthalpy on a continual basis. These values shall be made available to the system at all times.

Alarm shall be generated as follows:

- Sensor Failure: Sensor reading indicates shorted or disconnected sensor. In the event of a sensor failure, an alternate outside air conditions sensor shall be made available to the system without interruption in sensor readings.

If an OA Temp Sensor cannot be read, a default value of 65°F will be used.

If an OA Humidity Sensor cannot be read, a default value of 50 % will be used.

Outside Air Temperature History:

The controller shall monitor and record the high and low temperature readings for the outside air. These readings shall be recorded on a daily, month-to-date, and year-to-date basis.

HVAC Emergency Stop:

The controller shall shutdown all RTUs and ERVs upon the activation of the e-stop switch. All OA dampers and EA dampers shall close, allowing isolation of the building in an emergency situation.

The controller shall return to normal control of all systems upon deactivation of the e-stop switch.

Occupied Override Switch:

The controller shall override the occupancy schedules of all systems to be Occupied upon activation of the Occupied Override Switch.

The controller shall return to normal scheduling upon deactivation of the Occupied Override Switch.

Point Name	Hardware Points				Software Points						Show On Graphic
	AI	AO	BI	BO	AV	BV	Loop	Sched	Trend	Alarm	
Outside Air Humidity	x								x		x
Outside Air Temp	x								x		x
Outside Air Enthalpy					x				x		x
HVAC Emergency Stop			x						x		x
Occupied Override Switch			x						x		x
High Temp Month-to-Date									x		x
High Temp Today									x		x
High Temp Year-to-Date									x		x
Low Temp Month-to-Date									x		x
Low Temp Today									x		x
Low Temp Year-to-Date									x		x
Sensor Failure										x	
Totals	2	0	2	0	1	0	0	0	11	1	11

Total Hardware (4)

Total Software (13)

END OF SECTION 230993

SECTION 23 11 23

FACILITY NATURAL-GAS 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 SUMMARY

- A. Section Includes:
1. Natural gas piping above grade.
 2. Unions and flanges.
 3. Valves.
 4. Pipe hangers and supports.
 5. Strainers.
 6. Natural gas pressure regulators.
 7. Natural gas pressure relief valves.
- B. Related Sections:
1. Section 20 00 01 – General Requirements
 2. Section 20 00 02 – Definitions
 3. Section 20 05 29 – Hangers and Supports
 4. Section 20 05 53 – Identification for Piping and Equipment
 5. Section 05 12 00 - Structural Steel Framing: Product requirements for touch-up painting of structural steel.
 6. Section 07 84 46 - Firestopping
 7. Section 09 91 00 - Painting and Coating
 8. Section 31 05 13 - Soils for Earthwork: Soils for backfill in trenches.
 9. Section 31 05 16 - Aggregates for Earthwork: Aggregate for backfill in trenches.
 10. Section 31 23 16 - Excavation: Product and execution requirements for excavation and backfill required by this section.
 11. Section 31 23 17 - Trenching: Execution requirements for trenching required by this section.
 12. Section 31 23 23 - Fill: Requirements for backfill to be placed by this section.

1.3 REFERENCES

- A. American National Standards Institute:
1. ANSI Z21.15 - Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.
- B. American Society of Mechanical Engineers:
1. ASME B16.3 - Malleable Iron Threaded Fittings.
 2. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
 3. ASME B16.33 - Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psig (sizes 1/2 - 2).
 4. ASME B31.9 - Building Services Piping.
 5. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

- C. ASTM International:
 - 1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
 - 3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
 - 4. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
 - 5. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
 - 6. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
- D. American Welding Society:
 - 1. AWS D1.1 - Structural Welding Code - Steel.
- E. American Water Works Association:
 - 1. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
- F. Manufacturers Standardization Society of the Valve and Fittings Industry:
 - 1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
 - 2. MSS SP 67 - Butterfly Valves.
 - 3. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
 - 4. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
 - 5. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
 - 6. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
- G. National Fire Protection Association:
 - 1. NFPA 54 - National Fuel Gas Code.
- H. Underwriters Laboratories Inc.:
 - 1. UL 842 - Valves for Flammable Fluids.

1.4 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.
- B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves, equipment.
- C. Provide pipe hangers and supports in accordance with ASME B31.9, MSS SP 58, MSS SP 69, and MSS SP 89.
- D. Use ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data:

1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
 2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
 3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
 4. Piping Specialties: Submit manufacturers catalog information including capacity, rough-in requirements, and service sizes for the following:
 - a. Strainers.
 - b. Natural gas pressure regulators.
 - c. Natural gas pressure relief valves.
- C. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- D. Test Reports: Indicate results of piping system pressure test.
- E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
- F. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 73 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of valves, piping system, and system components.
- C. Operation and Maintenance Data: Submit for valves and gas pressure regulators, installation instructions, and spare parts lists.

1.7 QUALITY ASSURANCE

- A. Perform natural gas Work in accordance with NFPA 54.
- B. Perform work in accordance with state, local, and federal codes and local gas company requirements
- C. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.
- D. Furnish shutoff valves complying with ASME B16.33.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.9 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

- B. Convene minimum one week prior to commencing work of this section.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Protect piping and fittings from soil and debris with temporary end caps and closures. Maintain in place until installation. Furnish temporary protective coating on cast iron and steel valves.

1.11 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements.
- B. Do not install underground piping when bedding is wet or frozen.

1.12 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.13 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

1.14 WARRANTY

- A. Section 01 73 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for valves excluding packing.

1.15 EXTRA MATERIALS

- A. Section 01 73 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two packing kits for each type and size valve.

1.16 QUALIFICATIONS

- A. Contractor shall have a minimum of 10 years of experience with South Jersey Gas, and the installation of gas piping as specified herein.

PART 2 PRODUCTS

2.1 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M forged steel welding type.
 - 2. Joints: Threaded for pipe 2 inch and smaller; welded for pipe 2-1/2 inches and larger.

2.2 NATURAL GAS PIPING, BELOW GRADE

- A. MDPE Pipe: ASTM D3350, PE2406 Medium Density Polyethylene yellow.

1. IPS 2" and smaller – SDR10 minimum wall thickness
2. IPS greater than 2" – SDR11 minimum wall thickness
3. Fittings: ASTM D2513, PE 2708 MDPE electro-fusion or butt fusion.
4. Joints: ASTM D2513 PE 2708, Electro-fusion or butt fusion.

2.3 REGULATOR VENT PIPING, ABOVE GRADE

- A. Outdoors: Same as natural gas piping, above grade.

2.4 UNIONS AND FLANGES, ABOVE GRADE

- A. Unions for Pipe 2 inches and Smaller:
 1. Ferrous Piping: Class 150, malleable iron, threaded.
 2. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
- B. Flanges for Pipe 2-1/2 inches and Larger:
 1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
 2. Gaskets: 1/16 inch thick preformed neoprene gaskets.

2.5 BALL VALVES

- A. Manufacturers:
 1. Crane Valve, North America
 2. Milwaukee Valve Company
 3. NIBCO, Inc. Model
- B. 1/4 inch to 1 inch: MSS SP 110, Class 125, two piece, threaded ends, bronze body, chrome plated bronze ball, reinforced teflon seats, blow-out proof stem, lever handle, UL 842 listed for flammable liquids and LPG, full port.
- C. 1-1/4 inch to 3 inch: MSS SP 110, Class 125, two piece, threaded ends, bronze body, chrome plated bronze ball, reinforced teflon seats, blow-out proof stem, lever handle, UL 842 listed for flammable liquids and LPG, conventional port.

2.6 PLUG VALVES

- A. Manufacturers:
 1. DeZURIK, Unit of SPX Corp. Model
 2. Flow Control Equipment, Inc. Model
 3. Homestead Valve Model
- B. 2 inches and Smaller: MSS SP 78, Class 150, semi-steel construction, round port, full pipe area, pressure lubricated, teflon packing, threaded ends. Furnish one plug valve wrench for every ten plug-valves with minimum of one wrench.
- C. 2-1/2 inches and Larger: MSS SP 78, Class 150, semi-steel construction, round port, full pipe area, pressure lubricated, teflon packing, flanged ends. Worm gear operated. Provide chainwheel and chains for valves installed over 6'-0" above finished floor.

2.7 PE SHUT-OFF VALVES

- A. Manufacturers:
 1. Elster Perfection model PSV

- B. 2 inches and Smaller: SDR10 Butt Fusion, quarter turn, meeting or exceeding the requirements of ASTM D2513, US DOT Part 192, ISO 4439 and ANSI B16.40. Maintenance free operation with no cathodic protection required.
- C. Larger than 2 inches: SDR11 Butt Fusion, quarter turn, meeting or exceeding the requirements of ASTM D2513, US DOT Part 192, ISO 4439 and ANSI B16.40. Maintenance free operation with no cathodic protection required.
- D. Valve Box to be provided for access, follow manuf. Instructions for installation.

2.8 ANODELESS SERVICE RISERS

- A. Manufacturers:
 - 1. Elster Perfection model
- B. Below grade secondary seal, factory pressure tested to 150 psig, prebent as required, Medium Density PE 2406 wall thickness to match piping.

2.9 TRANSITION FITTINGS

- A. Manufacturers:
 - 1. Elster Perfection
- B. Steel-to-polyethylene transition, threaded and weld-end outlets as required, positive seal with added "O" ring protection, permanent factory assembly, pull-out strength greater than the PE piping. Meets or exceeds the requirements of ASTM D-2513 category 1, ANSI B1.20, ANSI B 31.8, US DOT Part 192, NFPA-58, and CSA B137.4. Available in PE 2406 (yellow).

2.10 STRAINERS

- A. Manufacturers:
 - 1. Mueller Steam Specialty Model
 - 2. Spirax Sarco, Inc. Model
- B. 2 inch and Smaller: Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.
- C. 2-1/2 inch to 4 inch Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

2.11 NATURAL GAS PRESSURE REGULATORS

- A. Manufacturers: Per Schedule or approved equal
- B. Product Description: Spring loaded, general purpose, self-operating service regulator including internal relief type diaphragm assembly and vent valve. Diaphragm case can be rotated 360 degrees in relation to body.
 - 1. Comply with ANSI Z21.80.
 - 2. Temperatures: minus 20 degrees F to 150 degrees F.
 - 3. Body: Steel
 - 4. Spring case, lower diaphragm casing, union ring, seat ring and disk holder: Aluminum.
 - 5. Disk, diaphragm, and O-ring: Nitrile
 - 6. Maximum inlet pressure: 150 psig
 - 7. Furnish sizes 2 inches and smaller with threaded ends. Furnish sizes 2-1/2 inches and larger with flanged ends.

2.12 UNDERGROUND PIPE MARKERS

- A. Plastic Ribbon Tape: Bright colored, continuously printed, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.
- B. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Natural Gas Service" in large letters.

2.13 NATURAL GAS PRESSURE RELIEF VALVES

- A. Manufacturers:
- B. Product Description: Spring loaded type relief valve.
 - 1. Body: Aluminum.
 - 2. Diaphragm: Nitrile
 - 3. Orifice: Stainless steel
 - 4. Maximum operating temperature: 150 degrees F.
 - 5. Inlet Connections: Threaded.
 - 6. Outlet or Vent Connection: Same size as inlet connection.

PART 3 EXECUTION

3.1 EXAMINATION

- A. 01300 - Administrative Requirements: Coordination and project conditions.
- B. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

- A. Ferrous Piping
 - 1. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
 - 2. Remove scale and dirt, on inside and outside, before assembly.
 - 3. Prepare piping connections to equipment with flanges or unions.
- B. MDPE Piping
 - 1. Chamfer pipe and tube ends. Remove burrs.
 - 2. Remove scale and dirt, on inside and outside, before assembly.

3.3 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install hangers and supports in accordance with ASME B31.9 and MSS SP 89.
- B. Support horizontal piping hangers as scheduled.
- C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.
- E. Install hangers to allow 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
- F. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.

- G. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.
- H. Prime coat exposed steel hangers and supports in accordance with Section 09 91 00.
- I. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

3.4 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

- A. Install natural gas piping in accordance with NFPA 54.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient.
- D. Where required, bend pipe with pipe bending tools in accordance with procedures intended for that purpose.
- E. Install piping to conserve building space and not interfere with use of space.
- F. Size and install gas piping to provide sufficient gas to supply maximum appliance demand at pressure higher than appliance minimum inlet pressure.
- G. Group piping whenever practical at common elevations.
- H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- I. Sleeve pipe passing through partitions, walls and floors.
- J. Provide access where valves and fittings are not exposed.
- K. Where pipe support members are welded to structural building framing, scrape, brush clean, weld, and apply one coat of zinc rich primer.
- L. Provide support for utility meters in accordance with requirements of utility company.
- M. Install vent piping from gas pressure reducing valves to outdoors and terminate in weatherproof hood. Protect vent against entry of insects and foreign material.
 - 1. Minimum Vent Size: Connection size at regulator vent connection.
 - 2. Run individual vent line from each relief device, independent of breather vents.
- N. Breather vents may be manifolded together with piping sized for combined appliance vent requirements.
- O. Prepare pipe, fittings, supports, and accessories not pre-finished, ready for finish painting. Refer to Section 09 91 00.
- P. Install identification on piping systems.
- Q. Install valves with stems upright or horizontal, not inverted.
- R. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

- S. Install gas pressure regulator with tee fitting between regulator and upstream shutoff valve. Cap or plug one opening of tee fitting.

3.5 INSTALLATION - BELOW GROUND PIPING SYSTEMS

- A. Install natural gas piping in accordance with NFPA 54.
- B. Provide Anodeless Service Line Risers for all transitions from below grade to above grade.
- C. Provide Saddle Fusion Tapping Tees for all low pressure building mains.
- D. Route piping in orderly manner and maintain gradient.
- E. Burial Depth of 12" minimum cover or in accordance with applicable codes or as indicated on plans, whichever is greater.
- F. Pipe shall be laid on grade and on a stable foundation. Unstable trench bottom soils shall be removed and a 6: foundation or bedding of compacted Class I material shall be installed to pipe bottom grade, all rocks to be removed a minimum of 6" around pipe, and backfilled with clean material.
- G. Trenches shall have all excess water removed. Where necessary, trench walls shall be shored or reinforced, and all necessary precautions shall be taken to ensure a safe working environment.
- H. Pipe shall be handled in a safe manner that avoids damage to the product. When lifting with slings, only wide fabric choker slings capable of safely carrying the load shall be used to lift, move or lower pipe and fittings. Wire rope or chain shall not be used. Slings shall be of sufficient capacity for the load and shall be inspected before use. Worn or damaged equipment shall not be used.
- I. Size and install gas piping to provide sufficient gas to supply maximum appliance demand at pressure higher than appliance minimum inlet pressure.
- J. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- K. Provide Valve Boxes for all buried valves.
- L. Install tracer wire on piping systems.
- M. Install valves with stems upright.
- N. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

3.6 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements, 01 73 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Where gas appliance will be damaged by test pressure, disconnect appliance and cap piping during pressure test. Reconnect appliance after pressure test and leak test connection.
- C. Where gas appliance is designed for operating pressures equal to or greater than piping test pressure, provide gas valve to isolate appliance or equipment from gas test pressure.

- D. Pressure test natural gas piping in accordance with NFPA 54.
- E. If Pressure tests do not meet specified requirements, remove defective work, replace and retest.
- F. Immediately after gas is applied to a new system, or a system has been restored after gas service interruption, check pipe for leakage.
 - 1. Where leakage is detected, shut off gas supply until necessary repairs are complete.
- G. Do not place appliances in service until leak testing and repairs are complete.
- H. Existing Under slab gas piping, to remain, shall be tested to 50 psig for a minimum of 1 hour, pressure shall not exceed 90 psig at any time. Vent sleeves are to be tested for the same pressure and duration. All deficiencies are to be brought to the attention of the owner's representative.

3.7 SCHEDULES

A. Pipe Hanger Spacing:

PIPE SIZE Inches	COPPER TUBING MAXIMUM HANGER SPACING Feet	STEEL PIPE MAXIMUM HANGER SPACING Feet	COPPER TUBING MINIMUM HANGER ROD DIAMETER Inches	STEEL PIPE MINIMUM HANGER ROD DIAMETER Inches
1/2	4	6	3/8	3/8
3/4	6	7	3/8	3/8
1	6	7	3/8	3/8
1-1/4	8	7	3/8	3/8
1-1/2	8	9	3/8	3/8
2	8	10	3/8	3/8
2-1/2	8	10	1/2	1/2
3	8	10	1/2	1/2

END OF SECTION 231123

SECTION 23 21 13

HYDRONIC PIPING

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 SECTION INCLUDES

- 1. Heating Water Piping, Above Ground
- 2. Drains and Overflows
- 3. Unions, Flanges, and Couplings
- 4. Ball Valves

1.03 RELATED SECTIONS

- A. General Conditions of the Construction Series Agreement.
- B. Division 01 – All Sections.
- C. Section 09 90 00 - Painting.
- D. Section 20 00 01 - General Requirements.
- E. Section 20 00 02 - Definitions.
- F. Section 20 05 53 - Identification for Piping and Equipment
- G. Section 20 05 30 - Vibration Isolation.
- H. Section 20 07 00 - Piping Insulation.
- I. Section 23 21 16 - Hydronic Piping Specialties.
- J. Section 23 25 00 – HVAC Water Treatment.
- K. Section 23 09 10 - Direct Digital Control Devices
- L. Section 23 09 00 - Instrumentation
- M. Section 23 05 93 - Testing, Adjusting, and Balancing.

1.04 REFERENCES

- A. ANSI B16.1 (ASA B16.1) – Cast Iron Pipe Flanges and Flanged Fittings.

- B. ANSI B16.5 (ASA B16.5) – Pipe Flanges and Flanged Fittings.
- C. ANSI B16.34 0 Valves – Flanged, Threaded, and Welding End.
- D. ANSI B16.104 – Control Valve Seat Leakage.
- E. API 609 – Butterfly Valves, Lug Type.
- F. MSS-SP-25 – Standard Marking System for Valves, Fittings, Flanges, and Unions.
- G. MSS-SP-44 – Steel Pipe Line Flanges.
- H. MSS-SP-68 – High Pressure-Offset Seat Butterfly Valves.
- I. API 601 – Gasket Compatibility.
- J. ASME B16.3 - Malleable Iron Threaded Fittings Class 50 and 300.
- K. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- L. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- M. ASME B31.5 - Refrigeration Piping.
- N. ASME B31.9 - Building Services Piping.
- O. ASME B31.1 – Power Piping.
- P. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
- Q. ASTM B32 - Solder Metal.
- R. ASTM B88 - Seamless Copper Water Tube.
- S. AWS A5.8 - Brazing Filler Metal.
- T. AWS D1.1 - Structural Welding Code.
- U. API 5L - Line Pipe
- V. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
- W. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
- X. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.05 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

- B. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, or other apparatus. (Exception: Chiller connections shall be welded.)
- C. Use non-conducting dielectric unions on flanges whenever jointing dissimilar metals in open systems.
- D. Provide pipe hangers and supports in accordance with MSS SP69 unless indicated otherwise.
- E. Use ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- F. Use ball or butterfly valves for throttling, bypass, or manual flow control services.
- G. Use spring loaded radial check valves on discharge of water pumps.
- H. Use only butterfly valves in chilled, and condenser water systems for throttling and isolation service.
- I. Use lug end butterfly valves only.
- J. Use $\frac{3}{4}$ inch ball valves with cap for drains at interior main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest floor drain.
- K. Use gate valves with cap for drains on all exterior piping.

1.06 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Product Data: Include data on materials, valves, actuators, and accessories. Provide manufacturers catalog information. Indicate valve data, ratings, wiring diagrams, control devices, contactors, overload protection, torque switches, position indications, diagnostic equipment, gearing, bearings, and housings
- C. Welders Certificate: Include welders certification of compliance with AWS D1.1.
- D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- E. Hydrostatic test results.

1.07 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01.
- B. Record actual locations of valves.

1.08 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 01.
- B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.09 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing the work of this section with minimum five years documented experience.
- C. Welders: Certify in accordance with AWS D1.1.

1.10 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9 code for installation of piping system.
- B. Welding Materials and Procedures: Conform to ASME SEC 9 and applicable state labor regulations.
- C. Provide certificate of compliance from authority having jurisdiction indicating approval of welders.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.12 OPERATION AND MAINTENANCE DATA

- A. Maintenance Data: Include calibration instructions, spare parts lists, exploded assembly views.

1.13 WARRANTY

- A. Valves – Labor and material for a minimum of two (2) years from date of startup or three (3) years from date of shipment for defects in materials and workmanship.
- B. Actuators – Full labor and material for a minimum of two (2) years from date of startup or three (3) years from date of shipment.

PART 2 PRODUCTS

2.01 HEATING WATER PIPING, ABOVE GROUND

- A. 2" and Above - Steel Pipe: ASTM A53, Schedule 40, black.
 - 1. Fittings: ASTM B16.3, malleable iron or ASTM A234, forged steel welding type fittings.
 - 2. Joints: Threaded, or AWS D1.1, welded.

- B. Up to 2" - Copper Tubing: ASTM B88, Type L, hard drawn.
 - 1. Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.
 - 2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
 - 3. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 - 1480 degrees F.
 - 4. Valves: Apollo 70-140/240 series

2.02 DRAINS AND OVERFLOWS

- A. Copper Tubing: ASTM B88, Type L, hard drawn.
 - 1. Fittings: ASME B16.22 solder wrought copper.
 - 2. Joints: Solder, ASTM B32.

2.03 UNIONS, FLANGES, AND COUPLINGS

- A. Unions for Pipe 2 Inches and Under:
 - 1. Ferrous Piping: 150 psig malleable iron, threaded.
 - 2. Copper Pipe: Class 50, bronze union with brazed joints.
 - 3. Dielectric Connections: Refer to Section 20 00 01.
 - 4. PVC piping; PVC.
- B. Dielectric Connections, Refer to Section 20 00 01.

2.05 GAGE PIPING

- A. Red Brass: ASTM B43, Schedule 40, seamless.
 - 1. Fittings: ANSI/ASME B16.15 cast brass.
 - 2. Joints: Threaded.

2.06 CONTROL AND INSTRUMENTATION TUBING

- A. Copper Tubing: ASTM B280, Type K, seamless, hard drawn or annealed.
 - 1. Fittings: ANSI/ASME B16.22, wrought copper.
 - 2. Joints: brazed or silver soldered.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

- E. After completion, fill, clean, and treat systems. Refer to Section 23 25 00

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install chilled water, and condenser water piping to ASME B31.1.
- C. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- D. Install piping to conserve building space, and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Sleeve pipe passing through partitions, walls and floors.
- G. Slope piping and arrange to drain at low points.
- H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- I. Anchor Bolts
 - 1. Provide steel expansion anchors. Length shall provide for 6" minimum embedment.
- J. Pipe Hangers and Supports:
 - 1. Install in accordance with ASTM B31.9 and MSS SP89.
 - 2. Support horizontal piping as scheduled.
 - 3. Install hangers to provide minimum ½ inch space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches of each horizontal elbow.
 - 5. Use hangers with 1½ inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 6. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
 - 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 8. Provide copper plated hangers and supports for copper piping.
 - 9. Prime coat steel hangers and supports.
- K. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 20 07 00.
- L. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- M. Where pipe support members are welded to structural building framing, scrape brush clean and apply one coat of zinc rich primer to welds.
- N. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.
- O. Install valves with stems upright or horizontal, not inverted.

- P. Water treatment piping connections to chilled and heating hot water systems including valves shall be installed with materials and valves specified for those systems. Downstream of valves may be installed with materials specified for water treatment systems.
- Q. All bared, rusted, or marred surfaces on steel pipe and pipe welds shall be painted with primer coat. Remove loose rust, loose mill scale, excess welding slag and splatter, slag or flux deposits. Clean steel in accordance with Steel Structures Painting Council (SSPC) SP-3 "Power Tool Cleaning". Immediately after surface preparation, apply steel primer paint in accordance with Manufacturer's instructions and at a rate to provide dry-film thickness of not less than 1.5 mils. Use painting methods which result in full coverage of joints, corners, edges, and exposed surfaces.

3.03 CLEANING OF PIPING

- A. The owner will furnish the potable water required for cleaning pipe or piping systems. The contractor shall furnish the instrument air required for cleaning the pipe or piping system. All piping systems shall be kept absolutely free of oil, grease, dirt, paint, and other foreign materials before and after erection. The cleaning requirements for all piping systems are included within this specification.

Cleaning requirements for that are applicable to each piping system:

PIPE SYSTEM CODE	SERVICE	CLEANING METHOD
HHW	Heating Hot Water	Water Flush
REFRIGERANT	Cooling	Nitrogen Flush

- B. **Cleaning Prior to Pipe Assembly:**
Prior to assembly of pipe and pipe components, all loose dirt, scale, oil and other foreign matter on internal or external surfaces shall be removed. Chips and burrs from machinery or threaded cutting operations shall be blown out of pipe before assembly. Cutting oil shall be wiped from internal and external surfaces.
- C. **Cleaning During Fabrication and Assembly:**
During fabrication and assembly, slag and weld spatter shall be removed from both internal and external pipe joints by grinding, peeling, chipping, and wire brushing. All partially installed piping systems shall have the open ends suitably capped (sealed) whenever the systems are left unattended. Prior to capping or sealing, ensure that loose bolts, nuts, small tools, rags, or any other foreign materials are not left inside the piping system.
- D. **Preparation for Cleaning Operation:**
The Owner representative shall be notified prior to starting any post-erection cleaning operation in sufficient time to allow witnessing the operation. Approval shall be obtained from the Owner representative with regard to specified procedures and scheduling. It shall be the contractor's responsibility to arrange for proper disposal of cleaning and flushing fluids. Prior to blowing or flushing erected piping systems, the contractor shall disconnect all instrumentation and equipment, open wide all valves and be certain all strainer screens are in place and wrapped with cheese cloth. After cleaning, remove the cheese cloth and clean the strainer. The contractor shall furnish and install all necessary valving, temporary piping, pumps, hoses, etc. in order to accomplish cleaning.

- E. **Cleaning By Air Blowing:**
Pipe and components shall be blown out with clean, compressed air. Instruments and plant compressed air lines shall be blown out with dry, oil-free air or nitrogen gas. "Dry" is defined as having a dew point at line pressure of -40°F or below. "Oil" free is defined as air compressed in centrifugal, Teflon, ring, carbon ring, or water-pumped air compressor. Where air supply is judged to be inadequate to continually attain cleaning velocity, alternate pressurization and sudden relief procedures may be used until discharge at all blowout points is clean. Pressure of 80-90 PSIG shall be used, unless otherwise indicated.
- F. **Cleaning By Water Flushing:**
Pipe and components shall be flushed with clean water until all discharge from the system is clean. A water sample from each system shall be analyzed for cleanliness after the system is flushed with clean water. If water analysis indicates that the system is not clean, the system shall be flushed with a pre-cleaning chemical designed to remove oil, pipe dope, loose mill scale, and other extraneous materials. The contractor shall submit proposed pre-cleaning chemicals to the Owner representative for approval. This cleaning shall be followed by water flushing as described.
- G. **Post-Cleaning Reassembly of the System:**
Following Owner representative's approval of flushing or blowing operation, instruments, equipment, and all items disconnected or blanked off shall be reconnected. Strainer screens shall be removed, cleaned, and reinstalled. The system shall then be prepared for testing.

3.04 TESTING

- A. After completion of the piping installation and prior to initial operation, conduct tests on the piping system. Provide materials and equipment required for tests. Correct defects disclosed by the test. Perform test after installation and in the presence of the Owner's Representative. Give 5 days notice prior to scheduling the tests. All costs associated with the testing shall be paid for by the Contractor, including all testing agency fees.
- B. **Chilled and Heating Hot Water:**

Hydrostatically test in accordance with the requirements of ANSI B31.9. Test piping system at one and one-half times system pressure but at least 100 psig with water not exceeding 100°F. Before tests, remove or isolate gauges, pumps, and other apparatus in the system that may be damaged. Repair leaks tightening or re-welding joints, or renewing pipe or fittings. Do not calk joints. Install a calibrated, test pressure gauge in the system to observe loss in pressure. Maintain the required test pressure for a minimum of 24 hours to enable an inspection of joints and connections. Correct defects disclosed by the test.
- C. **Refrigerant Systems:**

The refrigerant piping system shall be tested, using an oxygen-free nitrogen, helium or argon, as a whole or separate tests shall be conducted for the low-pressure side and high-pressure side of the piping system. The refrigerant piping system shall be tested in accordance with both of the following methods:
 - 1. The system shall be pressurized for a period of not less than 60 minutes to not less than the lower of the design pressures or the setting of the pressure relief device(s). The design pressures for testing shall be the pressure listed on the label nameplate of the condensing unit, compressor, compressor unit, pressure vessel or other system component with a nameplate. Additional test gas shall not

be added to the system after the start of the pressure test. The system shall not show loss of pressure on the test pressure measuring device during the pressure test. Where using refrigerant as a test medium in accordance with Section 1110.3, the test pressure shall be not less than the saturation dew point pressure at 77°F (25°C).

2. A vacuum of 500 microns shall be achieved. After achieving a vacuum, the system shall be isolated from the vacuum pump. The system pressure shall not rise above 1,500 microns for a period of not less than 10 minutes.

END OF SECTION 232113

SECTION 23 21 16

HYDRONIC SPECIALTIES

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 WORK INCLUDED

- A. Air vents.
- B. Strainers.
- C. Relief valves.
- D. Flexible Connections
- E. Air Separator
- F. Expansion Tank
- G. Control Valves

1.02 RELATED WORK

- A. General Conditions of the Construction Services Agreement.
- B. Division 1 - All Sections.
- C. Section 09 90 00 - Painting.
- D. Section 20 00 01 - General Requirements.
- E. Section 20 00 02 - Definitions.
- F. Section 23 07 00 - HVAC Insulation.
- G. Section 23 21 16 - Hydronic Piping.
- H. Section 23 21 23 – Hydronic Pumps

1.03 REFERENCES

- A. ANSI/ASME - Boilers and Pressure Vessels Code.

- B. ASME B40.1 - Gages - Pressure Indicating Dial Type - Elastic Element.
- C. FS-GG-G-76 - Gages, Pressure and Vacuum, Dial Indicating (for Air, Steam, Oil, Water, Ammonia, Chlorofluorohydrocarbon Gases, and Compressed Gases).

1.04 REGULATORY REQUIREMENTS

- A. Conform to ANSI/ASME Boilers and Pressure Vessels Code Section 8D for manufacture of tanks.

1.05 QUALITY ASSURANCE

- A. Manufacturer: For each product specified, provide components by same manufacturer throughout.

1.06 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Submit shop drawings and product data for manufactured products and assemblies required for this project.
- C. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.
- D. Submit inspection certificates for pressure vessels from authority having jurisdiction.
- E. Submit manufacturer's installation instruction: Indicate hanging and support methods, joining procedures.

1.07 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 20 00 01.
- B. Include installation instruction, assembly views, lubrication instructions, and replacement parts list.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 - PRODUCTS

2.01 AIR VENTS

- A. Manual: 3/4" nipple and ball valve with discharge nipple, hose connection, and cap.

2.02 STRAINERS

- A. Size 2 inch and under:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Muller #351 (Basis of Design)
 - b. Spirax/Sarco Co.
 - c. RP&C
 - d. Or equal as approved by the Professional
 - 2. Cast bronze for 150 PSIG working pressure, "Y" pattern with 1/32 inch stainless steel perforated screen.
- B. Size 2 1/2 inch to 4 inch:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Muller #758 (Basis of Design)
 - b. Spirax/Sarco Co.
 - c. RP&C
 - d. Or equal as approved by the Professional
 - 2. Flanged iron body for 150 PSIG working pressure, "Y" pattern with 3/64 inch stainless steel perforated screen.

2.03 RELIEF VALVES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Consolidated (Basis of Design)
 - 2. Spirax/Sarco Co.
 - 3. Crane
 - 4. Or equal as approved by the Professional
- B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled.
- C. Pressures to match rating of equipment or as indicated on the plans.

2.04 FLEXIBLE CONNECTIONS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

1. Metraflex (Basis of Design)
 2. Kinetics
 3. American Wheatly
 4. Or equal as approved by the Professional
- B. Elastoflex braided steel hose connectors with gasketless swivel connection, EPDM core, rated for 150 PSI and 5F-200F.

2.05 AIR SEPARATOR

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
1. Spirotherm, Spirovent Series VSR or VHR (Basis of Design)
 2. Bell and Gossett
 3. Amtrol
 4. Wessel
 5. TACO
 6. Or equal as approved by the Professional
- B. Selection shall be based upon system flow with pipe size as a minimum in accordance with the basis of design. In no case shall entering velocity exceed 10 feet per second. Separator shall be fabricated steel, rated for 150 psig working pressure, and stamped and registered in accordance with ASME Section VIII, Division 1 for unfired pressure vessels. The vessel diameter and height above the inlet / outlet connections must be equal to the basis of design. Unit shall include internal Spirotube® elements filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100% free air, 100% entrained air, and 99.6% dissolved air at the installed location. The elements must consist of a copper core tube with continuous wound copper wire medium permanently attached and followed by a separate continuous wound copper wire permanently affixed. Each unit shall have a separate venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism. Units shall include a valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.

2.06 DIAPHRAM TYPE EXPANSION TANK

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
1. Wessels model NLAP-40 (Basis of Design).
 2. ITT Bell and Gossett Series D
 3. John Wood Co.
 4. Amtrol, Inc.
 5. Wessels.
 6. TACO
 7. Armstrong
 8. Or equal as approved by the Professional
- B. Construction: Welded steel, tested and stamped in accordance with ASME SEC 8-D; supplied with National Board Form U-1, rated for working pressure of 125 psig, with flexible butyl diaphragm sealed into tank.
- C. Accessories: Pressure gage and air-charging fitting, tank drain; pre-charge to 12 psig.

- D. Size: As indicated.

2.07 CONTROL VALVES

- A. Equal percentage pressure independent characterized modulating control valve w/ 24V actuator.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Belimo (Basis of Design)
 - 2. Flowserve
 - 3. ALC
 - 4. Or equal as approved by the Professional
- C. Valve shall be rated for 400 psi, equal percentage, nickel plated brass body, chrome plated brass ball, chrome plated brass stem, Teflon PTFE Tefzel Seats, Viton Seat O-rings, brass/Tefzel characterizing disc, lubricated EPDM O-Rings, Nomex reinforced silicone/Polyester reinforced silicone Diaphragm, Stainless steel Regulator, Stainless steel Spring, ANSI Class IV Leakage.
- D. INSULATION: Valves shall be supplied with preformed polyurethane insulation for 1/2 – 2" TA Series 786/787 valves and for 2 1/2 – 6" TA Series 788/789 valve.

PART 3 - EXECUTION

3.01 INSTALLATION AND APPLICATION

- A. Install specialties in accordance with manufacturer's instructions to permit intended performance.
- B. Support tanks inside building in accordance with manufacturer's instructions.
- C. Provide manual air vents at all system high points and as indicated.
- D. Support pump fittings with floor mounted pipe and flange supports.
- E. Pipe relief valve outlet to nearest floor drain.
- F. Test piping systems per Section 23 21 13 prior to installing reinforcing saddles.
- G. Provide reinforcing saddles at all branch piping connections made with field or factory shaped nipples. Saddles are not required where factory made fittings (Weld-O-Lets) are installed per manufacturer's instructions.
- H. Where Weld-O-Lets are used, weld joint to skirt of Weld-O-Let.
- I. Refer to Section 23 21 13 for flushing requirements.
- J. Pipe strainer blowdowns full size, with ball valve and full-size hose connection.
- K. Shop fabricate piping system components and clean pipe of all debris. Where fish mouths are field cut, disconnect piping and remove all slag, debris, and filings. Plan and execute construction to permit cleaning of piping sections between flanges.

END OF SECTION 23 21 16

SECTION 23 21 23

HVAC HYDRONIC PUMPS 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 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.3 WORK INCLUDED

- A. Furnish and install all pumps for all systems which are part of the building HVAC systems. This shall include all accessories specified in this Division and as shown on the drawings.
- B. All pumps shall be new and manufactured for the specific purpose of circulating chemically treated water to the building HVAC systems.
- C. All pumps, circulators and system components shall be installed in accordance with state and local codes.
- D. Secure all permits and local/state approval for the components as specified and included under this Section.

1.4 RELATED SECTIONS

- A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.5 REFERENCES

- A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.
- B. Material standards shall be as specified or detailed hereinafter and as follows:
 - 1. NEMA MG1 – Motors and Generators; National Electrical Manufacturers Association.
 - 2. NEMA OS1 – Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports; National Electrical Manufacturers Association; 1989.
 - 3. NFPA 70 – National Electrical Code.
 - 4. UL 778 – Standard for Motor-Operated Water Pumps.

5. ASME – Section VIII, Unfired Pressure Vessels.

C. Reference Standards

1. AFBMA: Anti-Friction Bearing Manufacturers Association.
 - a. 1-84 - Terminology for Anti-Friction Ball and Roller Bearings and Parts.
 - b. 9-84 - Load Ratings and Fatigue Life for Ball Bearings.
 - c. 11-78 -Load Ratings and Fatigue Life for Roller Bearings.
 - d. 20-77 -Metric Ball and Roller Bearings Conforming to Basic Boundary Plans.
2. ASTM: American Society for Testing and Materials.
 - a. A 48-Gray Iron Castings.
 - b. B 62-Standard Specification for Composition Bronze or Ounce Metal Castings.
 - c. B 584-Standard Specification for Copper Alloy Sand Castings for General Applications.
3. HI: Hydraulics Institute.
 - a. Hydraulic Institute Standards.
4. ANSI B15.1
5. OSHA: Occupational Safety and Health Administration, U.S. Department of Labor.

1.6 SYSTEM DESCRIPTION

- A. Provide base mounted, horizontal axial split-case, or vertical mounted split-case, double-suction, single-stage centrifugal pumps, or base mounted, single-stage end suction radial pumps, as shown on the drawings. Capacity, RPM, head and electrical motor characteristics shall be as scheduled on the drawings.

1.7 SUBMITTALS

- A. See Section 230500 and General Conditions for additional information.
- B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics, connection requirements and all dimensional data including operating weights.
- C. Manufacturer's Installation Instructions: Indicate hanging and/or support requirements and recommendations.
- D. Millwright's Certificate: Certify that base mounted pumps have been aligned.
- E. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions and replacement parts list.
- F. In addition to items specified elsewhere provide:
 1. Large scale certified pump curves indicating operating points.
 2. Detailed motor data.
 3. Detailed coupling data
 4. Detailed seal data.

5. All pump construction data.
6. Detailed bearing data.
7. Base details
8. Dimensioned pump and motor drawing.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing, assembly and field performance of pumps, with minimum three (3) years of documented experience.
- B. Alignment: Base mounted pumps shall be aligned by qualified millwright.

1.9 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by UL 778 testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.
- B. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.10 DELIVERY, STORAGE AND HANDLING

- A. All pumps shall be delivered in containers and shall be kept in a dry and protected area.
- B. All pumps shall be given 2 coats of rust resistant paint at the factory prior to installation.

1.11 ENVIRONMENTAL

- A. Do not paint or install pumps when environmental conditions are outside the specific limitations of the referenced codes and manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS ACCEPTABLE FOR PRODUCT TYPES INDICATED CONTINGENT UPON PRODUCTS' COMPLIANCE WITH THE SPECIFICATIONS

- A. Vertical In-line with split coupling Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 1. Armstrong Model 4380-1205-001.5 (basis of design)
 2. Bell and Gossett
 3. TACO
 4. Grundfos
 5. Or equal as approved by the Professional
- B. In-line circulators Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

1. Armstrong (Basis of design)
2. Bell and Gossett
3. Aurora Pump Division
4. Weinman
5. TACO
6. Or equal as approved by the Professional

2.2 PUMPS GENERAL

- A. Statically and dynamically balance rotating parts.
- B. Construction shall permit complete servicing without breaking pipe or motor connections.
- C. Pumps to operate at 1750 rpm unless scheduled or specified otherwise.
- D. Pumps of the same type shall be from one pump manufacturer.
- E. Motors shall be in accordance with Section Motors, unless otherwise specified.
- F. Provide guards around shafts and couplings in accordance with OSHA and ANSI recommendations.
- G. All parts shall be suitable for Variable frequency drives; including but not limited to Motor, Pump, all pump components, coupling, and base. Provide AEGIS shaft grounding ring for all VFD motors up to and including 100 HP. Motors above 100 HP shall be electrically isolated with shielded cabling.
- H. Design and performance requirements:
 1. Scheduled design flow, design head, pump efficiency, and motor horsepower are minimum acceptable.
 2. Scheduled design brake horsepower and speed are maximum acceptable.
 3. Pump curve shall rise continuously from maximum flow to cut off.
 4. Shut-off head shall be approximately 20 percent greater than design head, unless otherwise indicated in pump schedules.
 5. Pump brake horsepower not to exceed motor horsepower rating over entire operating range (from shut-off to run-out). Motor shall not operate in service factor
 6. Suitable for parallel operation.
 7. Pumps shall operate within the preferred operation region as defined by the Hydraulics Institute.
 8. Select pump for operation at or near peak efficiency.
 9. Cavitation-free at all points on curve.
 10. Impeller diameter shall not exceed 90 percent of the maximum cutwater diameter.
 11. Vibration levels of pump shall be within the vibration limits established by hydraulic institute.

2.3 VERTICAL IN-LINE PUMPS

- A. Type: Centrifugal, single or multi-stage where noted, base mounted flexible coupled, single or double suction as noted, with integrated intelligent controls/optimized intelligent standalone controls.
1. Casing:
 - a. Casing shall be constructed of cast iron ASTM A 48 Class 30A or better, E-coated.
 - b. Casing shall be rated for 1.5 times the scheduled working pressure with a minimum rating of 150 psig.
 - c. Cast iron castings shall be sound and free of shrink holes, blow holes, cracks, scale, blisters and other defects.
 - d. Casing shall have flanged suction and discharge per ANSI B16.1 for sizes 2-1/2 inch and larger. Smaller sizes shall be threaded connections.
 - e. Casing shall have a tapped and threaded plug for an air vent.
 - f. Casing shall be provided with a threaded drain plug at the lowest point.
 - g. Casing shall be provided with a seal flush connection.
 - h. Casing wearing rings shall be replaceable and constructed of bronze ASTM B 584 or ASTM B 62.
 - i. Casing shall be base supported.
 - j. Casing shall be vertically or horizontally split as indicated.
 2. Impeller:
 - a. Impeller shall be constructed of one piece bronze ASTM B 584 or ASTM B 62.
 - b. Fully enclosed design.
 - c. Impeller shall be keyed to the shaft and secured with a stainless steel, 300 series washer and bolt. Bolt to tighten in direction opposite rotation of impeller.
 - d. Dynamically balanced for smooth, low vibration operation over the operating range from shut-off to run out.
 - e. Impeller shall be provided with replaceable wear rings.
 3. Shaft:
 - a. Shaft shall be solid stainless steel AISI 316 turned, ground and polished and ring gauged for accuracy.
 - b. Shafts shall be polished to a minimum 16 microinch finish.
 - c. Shaft deflection shall not exceed 0.002 inches in the round.
 4. Shaft sleeve:
 - a. Design such that there is no contact between the pump shaft and the pumped liquid.
 - b. Shaft sleeve shall be stainless steel, AISI 316 or AISI 416.
 - c. Provide O-ring or gasket to prevent leakage of pumped liquid.
 5. Shaft seals:
 - a. Mechanical type.
 - 1) Stainless steel hardware and spring.
 - 2) EPT rings, carbon rotating face against a tungsten carbide nickel binder seat.

- 3) Seals shall be balanced type for all pumps with 100 psig or greater suction pressure.
 - 4) API 610 seal number: USTFM. Similar to John Crane Type 1 or 2 material code **0₍₂₈₎-P₍₆₆₎-1-0₍₁₅₎-1**.
 - 5) Provide a bypass line from the discharge side of the pump casing to the seal faces. Design to ensure adequate flushing and proper lubrication.
- b. Provide Doxie or equal cyclone separator only on seal flushing lines on all pumps with a head of 25 PSIG or greater.
6. Bearings:
 - a. Grease lubricated ball bearings.
 - b. L-10 life minimum 100,000 hours.
7. Motor:
 - a. Refer to Section 230513 "Motors and Controllers" for requirements.
8. Drive coupling:
 - a. Flexible coupling with OSHA and ANSI type coupling guard.
 - b. Suitable for variable speed drive.
 - c. Suitable for system duty, fluid, and service temperature.
 - d. Similar to T.B. Woods (the coupling service factor shall not be less than 2).
9. Base:
 - a. Cast iron or fabricated steel base with drip rim and tapped NPT connection for drain.
 - b. Common base for pump and motor.
10. Painting:
 - a. Pump components shall be thoroughly degreased, deburred and sandblasted as required before the application of any primers or paint.
 - b. Prime coat components before assembly; finish coat after assembly.
11. Nameplate:
 - a. Provide pump with a nameplate constructed of 18-8 stainless steel securely fastened to pump casing by stainless steel pins.
 - b. Locate nameplate for easy visibility.
12. The rating conditions and other data below, as a minimum, shall be clearly stamped on the nameplate.
 - a. Manufacturer, address, telephone number.
 - b. Pump model number.
 - c. Pump serial number.
 - d. Size (including impeller diameter scheduled in inches).
 - e. Type.
 - f. Equipment designation as listed on the pump schedule.
 - g. Flow scheduled (gallons per minute).
 - h. Dynamic head scheduled (feet of water).

- i. Efficiency (percent).
 - j. Shut-off head (feet of water).
 - k. Speed (RPM).
- 13. Pump Controls:
 - a. Controls integrated with UL type 12 minimum enclosure rating, senseless controls complete with fused disconnect switch and menu-driven graphical keypad interface.

PART 3 – EXECUTION

3.1 PUMP INSTALLATION

- A. Pumps shall be installed so as to ensure easy accessibility for service or removal and replacement of all components such as, but not limited to, impellers, motors, drive couplings, bearings, strainers, other pump appurtenances and isolators.
- B. The Contractor shall receive and inspect all pumps and motors to ensure they are received without defect.
- C. All defective or damaged pumps shall be returned to the manufacturer by the Contractor for replacement.
- D. The Contractor shall properly protect all equipment to prevent damage from water, dirt, etc. Protection shall include temporary plastic wrap to keep equipment in original factory condition.
- E. Set pump on concrete base, anchor, level and grout according to manufacturer's instructions. Where specified or where indicated in the equipment schedule on the mechanical drawings provide vibration isolators under pump base.
- F. Provide line sized shutoff valve and strainer on suction and line sized silent check valve and flow control balancing valve or triple duty valve on discharge unless otherwise noted on mechanical drawings.
- G. Decrease from line size, with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
- H. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.
- I. Refer to pump detail on mechanical drawings for other accessories to be provided.
- J. Provide drains for bases and stuffing boxes piped to and discharging over floor drain. Provide air cock and drain connection on horizontal pump casings.
- K. Manufacturer representative shall check, laser align, and certify base mounted pumps 7.5 motor horsepower and over, before start-up. Pump and drive shall be aligned in accordance with Hydraulic Institute Standards. Submit copy of certified report.

- L. Pumps shall be installed so as to ensure easy accessibility for service or removal and replacement of all components such as, but not limited to, impellers, motors, drive couplings, bearings, strainers, other pump appurtenances, isolators, and flex connections.
- M. The Contractor shall receive and inspect all pumps and motors to ensure they are received without defect. All defective or damaged pumps shall be replaced.
- N. The Contractor shall properly protect all equipment to prevent damage from water, dirt, etc. All damaged pumps or accessories shall be replaced at the Contractor's expense.

3.2 EXPANSION TANK

- A. Provide where indicated in the drawings.
- B. Install in accordance with manufacturer's installation instructions.
- C. Charge with air to the specified pressure prior to the system fill.

3.3 AIR SEPARATOR

- A. Provide where indicated on the drawings.
- B. Install in accordance with manufacturer's instructions.

END OF SECTION 232123

SECTION 23 23 00

REFRIGERANT PIPING

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. Refrigerant piping.
 - 2. Unions, flanges, and couplings.
 - 3. Pipe hangers and supports.
 - 4. Refrigerant moisture and liquid indicators.
 - 5. Valves.
 - 6. Refrigerant filter-driers.
- B. Related Sections:
 - 1. Section 07 53 23 - Firestopping: Product requirements for firestopping for placement by this section.
 - 2. Section 20 05 29 - Hangers and Supports: Product requirements for pipe hangers and supports, sleeves, for placement by this section.
 - 3. Section 20 05 53 - Identification for Piping and Equipment: Product requirements for pipe identification for placement by this section.
 - 4. Section 20 07 00 - HVAC Insulation: Product requirements for Piping Insulation for placement by this section.

1.3 REFERENCES

- A. Air-Conditioning and Refrigeration Institute:
 - 1. ARI 495 - Refrigerant Liquid Receivers.
 - 2. ARI 710 - Liquid-Line Driers.
 - 3. ARI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter Dryers.
 - 4. ARI 750 - Thermostatic Refrigerant Expansion Valves.
 - 5. ARI 760 - Solenoid Valves for Use with Volatile Refrigerants.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 15 - Safety Code for Mechanical Refrigeration.
- C. American Society of Mechanical Engineers:
 - 1. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - 2. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
 - 3. ASME B31.5 - Refrigeration Piping.
 - 4. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.
- D. ASTM International:
 - 1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
 3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
 4. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
 5. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
 6. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
- E. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
 2. AWS D1.1 - Structural Welding Code - Steel.
- F. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
 2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
 3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- G. Underwriters Laboratories Inc.:
1. UL 429 - Electrically Operated Valves.

1.4 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.
- B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves or equipment.
- C. Provide pipe hangers and supports in accordance with ASME B31.5, MSS SP 58, MSS SP 69, and MSS SP 89.

1.5 SUBMITTALS

- A. Shop Drawings: Indicate layout of refrigeration piping system, including equipment, critical dimensions, and sizes.
- B. Product Data:
1. Piping: Submit data on pipe materials, fittings, and accessories.
 2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
 3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
 4. Refrigerant Specialties: Submit manufacturers catalog information including capacity, component sizes, rough-in requirements, and service sizes for the following:
 - a. Refrigerant moisture and liquid indicators.
 - b. Refrigerant filter-driers.
- C. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- D. Test Reports: Indicate results of refrigerant leak test per EPA standards.

- E. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of valves, equipment and refrigerant accessories.
- C. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.7 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.5 code for installation of refrigerant piping systems.
- B. Perform Work in accordance with applicable code and DMVA Standards.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years documented experience and approved by manufacturer.
- C. Design piping system, hangers and supports as directed by the manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Dehydrate and charge refrigeration components including piping and receivers, seal prior to shipment. Maintain seal until connected into system.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.11 WARRANTY

- A. Furnish five year manufacturer warranty for valves excluding packing.

PART 2 PRODUCTS

2.1 REFRIGERANT PIPING

- A. Copper Tubing: ASTM B280, ACR, hard drawn, seamless copper tube.
 - 1. Fittings: ASME B16.22 wrought copper.
 - 2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F

2.2 UNIONS, FLANGES, AND COUPLINGS

- A. 2 inches and Smaller:
 - 1. Copper Pipe: Bronze, Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F

2.3 PIPE HANGERS AND SUPPORTS

- A. Conform to ASME B31.5, MSS SP 58, MSS SP 69, and MSS SP 89.
- B. Hangers: copper, adjustable swivel, split ring.
- C. Vertical Support: copper riser clamp.
- D. Copper Pipe Support: Carbon steel rings, adjustable, copper plated.
- E. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

2.4 REFRIGERANT MOISTURE AND LIQUID INDICATORS

- A. Indicators:
 - 1. Port: Single, UL listed.
 - 2. Body: Copper solder ends.
 - 3. Sight glass: Color-coded paper moisture indicator and plastic cap.
 - 4. Maximum working pressure: 500 psig
 - 5. Maximum working temperature: 200 degrees F.

2.5 VALVES

- A. Service Valves:
 - 1. Forged brass body with copper stubs, brass caps, removable valve core, flared or solder ends.
 - 2. Maximum working pressure: 500 psig.

2.6 REFRIGERANT FILTER-DRIERS

- A. Replaceable Cartridge Angle Type:
 - 1. Shell: ARI 710, UL listed, brass, removable cap, for maximum working pressure of 500 psig.
 - 2. Filter/Dryer Cartridge: Pleated media with solid core sieve with activated alumina, ARI 730 rating for 150% of unit tons.

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.2 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install hangers and supports in accordance with ASME B31.5, and MSS SP 89.
- B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- C. Place hangers within 12 inches of each horizontal elbow.
- D. Install hangers to allow 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
- E. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
- F. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.
- G. Provide copper plated hangers and supports for copper piping.
- H. Prime coat and paint exposed steel hangers and supports.
- I. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

3.3 INSTALLATION

- A. Route piping parallel to building structure and maintain gradient.
- B. Install piping to conserve building space, and not interfere with use of space.
- C. Group piping whenever practical at common elevations.
- D. Sleeve pipe passing through partitions, walls and floors.
- E. Install pipe identification.

- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Provide access where valves and fittings are not exposed.
- H. Arrange refrigerant piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
- I. Flood refrigerant piping system with nitrogen when brazing.
- J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- K. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.
- L. Install valves with stems upright or horizontal, not inverted.
- M. Insulate piping.
- N. Provide replaceable cartridge filter-dryers, with isolation valves and bypass with valve.
- O. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
- P. Fully charge completed system with refrigerant after testing.
- Q. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.
- R. Install refrigerant piping in accordance with ASME B31.5 and manufacturers recommendations.

3.4 INSTALLATION - REFRIGERANT SPECIALTIES

- A. Refrigerant Liquid Indicators:
 - 1. Install line size liquid indicators in main liquid line downstream of condenser.
 - 2. When receiver is provided, install line size liquid indicators in liquid line downstream of receiver.
 - 3. Install line size liquid indicators downstream of liquid solenoid valves.
- B. Refrigerant Valves:
 - 1. Install service valves on indoor and outdoor suction and discharge.
 - 2. Install gage taps at compressor inlet and outlet.
 - 3. Install refrigerant charging valve in liquid line between receiver shut-off valve and expansion valve.
- C. Filter-Dryers:
 - 1. Install replaceable cartridge filter-dryer vertically in liquid line.

3.5 FIELD QUALITY CONTROL

- A. Test refrigeration system in accordance with ASME B31.5.
- B. Pressure test refrigeration system with dry nitrogen to 200 psig. Perform final tests at 27 inches vacuum and 200 psig using electronic leak detector.

- C. Repair leaks.
- D. Retest until no leaks are detected.

3.6 SCHEDULES

A. Pipe Hanger Spacing:

PIPE SIZE Inches	COPPER TUBING MAXIMUM HANGER SPACING Feet	STEEL PIPE MAXIMUM HANGER SPACING Feet	MINIMUM HANGER ROD DIAMETER COPPER TUBING Inches	MINIMUM HANGER ROD DIAMETER STEEL PIPE Inches
1/2	5	7	3/8	3/8
3/4	5	7	3/8	3/8
1	6	7	3/8	3/8
1-1/4	7	7	3/8	3/8
1-1/2	8	9	3/8	3/8
2	8	10	3/8	3/8
2-1/2	9	11	1/2	1/2
3	10	12	1/2	1/2
4	10	12	1/2	5/8
5	10	12	1/2	5/8
6	10	12	5/8	3/4

END OF SECTION 232300

SECTION 23 31 00

DUCTWORK

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 SECTION INCLUDES

- A. Materials
- B. Ductwork Fabrication
- C. Ductmate System
- D. Casings Plenums

1.3 RELATED SECTIONS

- A. Section 09 90 00 - Painting: Weld priming, weather resistant, paint or coating.
- B. Section 20 00 01 - General Requirements.
- C. Section 20 00 02 - Definitions.
- D. Section 20 05 29 - Hangers and Supports
- E. Section 23 07 10 - Duct insulation
- F. Section 23 33 00 - Ductwork Accessories.
- G. Section 23 37 00 - Air Inlets and Outlets.
- H. Section 23 05 93 - Testing, Adjusting, Balancing and Commissioning.

1.4 REFERENCES

- A. ASTM A 36 - Structural Steel.
- B. ASTM A 90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
- C. ASTM A 525 - General Requirements for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process.
- D. ASTM A 527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot Dip Process, Lock Forming Quality.
- E. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

- F. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.
- G. SMACNA - HVAC Air Duct Leakage Test Manual.
- H. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- I. UL 181 - Factory-Made Air Ducts and Connectors.

1.5 PERFORMANCE REQUIREMENTS

- A. No variation of duct configuration or sizes permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.6 SUBMITTALS

- A. Submit under provisions of Division 01. Submittals
- B. Shop Drawings: Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work. Sheetmetal shop drawings shall be prepared at a minimum scale of 3/8"=1'-0" and shall be in AutoCAD V12 or later.
- C. Product Data: Provide data for duct materials.
- D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.

1.7 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 20 00 01.
- B. Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.8 QUALITY ASSURANCE

- A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- B. Maintain one copy of document on site.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing the work of this section with minimum three years documented experience.

1.10 REGULATORY REQUIREMENTS

- A. Construct ductwork to NFPA 90A and NFPA 90B standards.

1.11 ENVIRONMENTAL REQUIREMENTS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures during and after installation of duct sealants.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Interior Ductwork: Galvanized Steel Ducts, ASTM A924 and ASTM A653 galvanized steel sheet, lock-forming quality, having G60 zinc coating of in conformance with ASTM A90.

DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- B. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide air foil turning vanes.
- C. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- D. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Joints shall be minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.
- E. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.
- F. All elbows shall have single thickness turning vanes.
- G. Seal Class: Class A for all ductwork.
- H. Pressure Class:
 - 1. Ductwork upstream of VAV Boxes: +2.0 inches of water
 - 2. Ductwork downstream of VAV Boxes: + 1.0 inches of water gauge
 - 3. Return Air Ductwork: +/- 2.0 inches of water gauge
 - 4. Exhaust Ductwork: +/- 2.0 inches of water gauge
- I. Internal tie-rod supports are not acceptable.

2.3 DUCTMATE SYSTEM

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Ductmate Industries, Inc. (Basis of Design)
 - 2. MKT Metal Manufacturing
 - 3. Hardcast

- 4. Or equal as approved by the Professional
- B. Ductmate '35' angle shall be roll-formed from galvanized steel with an integral sealant.
- C. Metal cleat shall be roll-formed from galvanized steel.
- D. Gasket shall be extruded butyl for use between mating flanges.
- E. Corner clips shall be 16 GA galvanized steel.
- F. Accessories:
 - 1. Angle Steel: ASTM A-527 G 60/90.
 - 2. Corner Steel: ASTM A-526 G 60/90.
 - 3. Mastic: 5511 M.
 - 4. Gasket: Ductmate 440

2.4 ROUND DUCTWORK

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Ductmate Industries, Inc. (Basis of Design)
 - 2. MKT Metal Manufacturing
 - 3. Nordfab
 - 4. Greenseam Plus
 - 5. Or equal as approved by the Professional
- B. Spiralmate
- C. Closure ring shall be roll-formed from galvanized steel.
- D. Gasket shall be extruded butyl for use between mating flanges.
- E. Corner clips shall be 16 GA galvanized steel.
- F. Accessories:
 - 1. Angle Steel: ASTM A-527 G 60/90.
 - 2. Mastic: 5511 M.
 - 3. Gasket: Ductmate 440

2.5 CASINGS PLENUMS

- A. Fabricate casing in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and construct for operating pressures indicated.
- B. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible. All rectangular ducts shall have joints constructed with ductmate.
- C. Duct Sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- D. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- E. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- F. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.
- G. Use double nuts and lock washers on threaded rod supports.
- H. Connect diffuser or register boots to pressure ducts directly unless otherwise indicated.
- I. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- J. All ductmate joints shall utilize ductmate gasket tape. Duct sealant in place of gasket tape is not acceptable.

3.2 CLEANING

- A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

3.3 SCHEDULES

A. DUCTWORK MATERIAL SCHEDULE

AIR SYSTEM

MATERIAL

Interior/Exterior Low Pressure Supply,
Return, Relief, and Exhaust

Galvanized Steel

END OF SECTION 233100

SECTION 23 33 00

DUCTWORK 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 SECTION INCLUDES

- A. Duct access doors
- B. Duct test holes
- C. Flexible duct connections
- D. Manual and control dampers
- E. Air turning vanes
- F. Fire Dampers

1.3 RELATED SECTIONS

- A. Section 20 00 01 - General Requirements.
- B. Section 20 00 02 - Definitions.
- C. Section 23 31 00 - Ductwork
- D. Section 23 37 00 - Air Outlets and Inlets.

1.4 REFERENCES

- A. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- B. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

1.5 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers, duct access doors and duct test holes.

1.6 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 20 00 01.

- B. Record actual locations of access doors and test holes.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01.
- B. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.1 DUCT ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Ductmate (Basis of Design)
 - 2. Elgen
 - 3. Acudor
 - 4. Or equal as approved by the Professional
- B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
- C. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.
 - 1. Less Than 12 Inches Square: Secure with sash locks.
 - 2. Up to 18 Inches Square: Provide two hinges and two sash locks.
 - 3. Up to 24 X 48 Inches: Three hinges and two compression latches with outside and inside handles.
- D. Access doors with sheet metal screw fasteners are not acceptable.

2.2 DUCT TEST HOLES

- A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.3 FLEXIBLE DUCT CONNECTIONS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
- B. Connector: Fabric crimped into metal edging strip.

1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz. per sq. yd.
2. Net Fabric Width: Approximately 6 inches wide.
3. Metal: 3 inch wide, 24 gauge galvanized steel.

2.4 RECTANGULAR MANUAL AND CONTROL DAMPERS.

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 1. Tamco, Series 1000 opposed blade (Basis of Design)
 2. Ruskin
 3. Nailor
 4. Pottorff
 5. Or equal as approved by the Professional.
- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Seal and Pressures classes for all dampers shall be rated for static pressure ratings listed in the ductwork fabrication section, specification Section 23 31 00.
- B. Single Blade Dampers: Fabricate for duct sizes up to 6 X 30 inch.
- C. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 X 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
- D. End Bearings: provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.
- E. Quadrants:
 1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
 2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
 3. Where rod lengths exceed 30 inches provide regulator at both ends.

2.5 ROUND MANUAL AND CONTROL DAMPERS.

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 1. Elgen HET (Basis of Design)
 2. GreenSeam Plus
 3. Metal Zinc
 4. Or equal as approved by the Professional.
- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Seal and Pressures classes for all dampers shall be rated for static pressure ratings listed in the ductwork fabrication section, specification Section 23 31 00.
- B. HETO (High Efficiency Take Off) type takeoff to mate up to Rectangular or Round Ducts.
- C. Heavy Duty standoff to accommodate insulation thickness.

- D. Welded Seams
- E. Rossi Twistlock regulator.

2.5 AIR TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Aero Dyne, model H-E-P (Basis of Design)
 - 2. Duro Dyne
 - 3. Duct Mate
 - 4. Or equal as approved by the Professional.
- A. Multi-blade device with radius blades attached to pivoting frame and bracket, aluminum construction, with push-pull operator strap.
- B. High Efficiency Profile turning vanes spaced on 2.4 inch centers with 3 inch radius.

2.6 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Air Balance, Inc. (Basis of Design)
 - 2. Ruskin
 - 3. Greenheck
 - 4. Pottorff
 - 5. Or equal as approved by the Professional.
- A. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.
- B. Curtain Type Dampers: Galvanized steel with interlocking blades, provide stainless steel closure springs and latches, configure with blades out of air stream (Type B).
- C. Fusible Links: UL 33, separate at 160°F

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 23 31 00 for duct construction.
- B. Provide duct access doors for inspection and maintenance as indicated. Provide minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated. Review locations prior to fabrication.
- C. Install 8 x 8 inch size duct access doors upstream and downstream of all coils installed in ductwork. Doors shall be installed within 6 inches of coils.
- D. Install 8 x 8 inch size duct access doors upstream of all fire dampers. Doors shall be installed within 6 inches of fire dampers.

- E. Provide duct test holes where indicated and required for testing and balancing purposes.
- F. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.
- G. Provide balancing dampers at points on supply and return systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
- H. Use splitter dampers only where indicated.
- I. Provide balancing dampers on duct take-off to diffusers, registers, and grilles regardless of whether dampers are specified as part of the diffuser or register assembly.
- J. Provide fire dampers where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- K. Demonstrate re-setting of fire dampers to authorities having jurisdiction and Owner's representative.

END OF SECTION 233300

SECTION 23 36 00

AIR TERMINAL UNITS

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. Variable air volume terminal units.
 - 2. Dehumidifiers.
- B. Related Sections:
 - 1. Section 23 09 23 - Direct-Digital Control System for HVAC
 - 2. Section 23 09 93 - Sequence of Operations for HVAC Controls
 - 3. Section 26 05 03 - Equipment Wiring Connections

1.3 REFERENCES

- A. American Refrigeration Institute:
 - 1. ARI 880 - Air Terminals.
 - 2. ARI 885 - Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.
- B. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- C. National Fire Protection Association:
 - 1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
- D. Underwriters Laboratories Inc.:
 - 1. UL 181 - Factory-Made Air Ducts and Connectors.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures.
- B. Product Data: Submit data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings indicating airflow, static pressure, [heating coil capacity] and NC designation. Include electrical characteristics and connection requirements. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 1 inch to 4 inches wg.
- C. Manufacturer's Installation Instructions: Submit support and hanging details, and service clearances required.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements

B. Project Record Documents: Record actual locations of units, controls components, piping system and ductwork system.

C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant volume regulators.

1.6 QUALITY ASSURANCE

A. Test and rate air terminal units performance for air pressure drop, flow performance, and acoustical performance in accordance with ARI 880 and ARI 885. Attach ARI seal to each terminal unit.

B. Perform Work in accordance with the local adopted codes.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum ten years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.8 PRE-INSTALLATION MEETINGS

A. Convene minimum four weeks prior to commencing work of this section.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to developing submittals, shop drawings, and fabrication.

1.10 COORDINATION

A. Section 01 31 00 - Coordination

B. Coordinate Work with Division 23

1.11 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements

B. Furnish five year manufacturer warranty for air terminal units.

1.12 EXTRA MATERIALS

A. Furnish two additional electric motors of each size of fan powered terminal units.

PART 2 PRODUCTS

2.1 VARIABLE AIR VOLUME TERMINAL UNITS

A. Description:

1. Furnish and install single duct terminal units in the sizes and configurations as indicated on the plans.
2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Price model SDV (Basis of Design)
 - b. Greenheck model XG-TH-500
 - c. Titus model DESV
 - d. Nailor Model D30RW
 - e. Or equal as approved by the Professional

B. Unit Casing:

1. The unit casing shall be constructed of a minimum 22 gauge, 0.032 inch galvanized steel.
 - a. The casing shall be assembled with longitudinal lock seam construction.
 - b. Casing leakage shall be tested in accordance with ASHRAE 130.
 - c. Casing leakage for the basic assembly shall not exceed 1.0 percent of the maximum rated airflow at 1.0 inches of water gauge.
 - d. Casing leakage for the basic assembly shall not exceed 2.0 percent of the maximum rated airflow at 3.0 inches of water gauge.

A. Unit Discharge:

1. Manufacturer shall provide rectangular unit discharges with slip-and-drive connections.

B. Liners:

1. Optional:

- a. Fiber-Free Foam Insulation - FF. Insulation shall comply with the requirements of UL 181 (erosion, mold growth and humidity) and ASHRAE 62.1, and shall have a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.
 1. The insulation shall be secured with adhesive.
 2. Insulation thickness shall be:
 - a. 1/2 inch thick, R-value of 2.0.

C. Primary Air Damper Assembly:

1. The damper assembly shall be heavy-gauge, galvanized steel with a solid shaft rotating in bearings.
2. The damper shaft shall incorporate a visual position indicator etched into the end of the damper shaft to clearly indicate damper position over the full range of 90 degrees.
3. The damper shaft shall be mounted on the [left], [right], [top], or [bottom] of the damper when looking in the direction of airflow.
4. The 18 gauge damper assembly shall incorporate a peripheral gasket on the damper blades for tight airflow shutoff.
5. Air leakage past the closed damper shall not exceed 2 percent of the unit maximum rated airflow at 3.0 inch water gauge inlet static pressure, tested in accordance with ASHRAE 130.

6. The damper, seal, and bearing system shall be tested to 1.25 million cycles, or the equivalent of 100 full open/closures per day for 35 years, with no visible signs of wear, tear, or failure of the damper assembly after such testing.

D. Airflow Sensor:

1. The airflow sensor shall be a differential pressure airflow device measuring total and static pressures, and mounted to the inlet valve.
2. Plastic parts shall be fire-resistant, complying with UL 94.
3. The airflow sensor shall be RoHS (Restriction of Hazardous Substances) compliant. Material containing polybrominated compounds shall not be acceptable.
4. Control tubing shall be protected by grommets at the wall of the airflow sensor's housing.
5. The airflow sensor shall be furnished with twelve total pressure sensing ports and four static pressure sensing ports, and shall include a center averaging chamber that amplifies the sensed airflow signal.
6. After balancing, the airflow sensor signal accuracy shall be plus or minus five percent throughout terminal operating range.

E. Inlet Valve - Standard:

1. The inlet valve shall be a consistent diameter to retain flex duct and provide a stop for hard duct.
2. The inlet valve shall include a 1/8 inch raised single bead weld for added strength.
3. The gasket seal shall be a low leakage continuous piece with a peripheral gasket for tight airflow shutoff.
4. The inlet valve shall include two heavy duty stop pins to accurately position the damper in the closed and open positions.

F. Options:

1. Bottom Access Door:
 - b. The unit shall be supplied with a 4 inch x 6-3/4 inch bottom access door, secured to the casing with:
 1. Quarter turn sash latches.
2. Hot Water Heating Coil:
 - a. The hot water coil casing shall be constructed from a minimum 22 gauge, 0.032 inch galvanized steel, factory-installed on the terminal discharge with slip-and drive attachment for downstream ductwork.
 1. An optional gasketed access door shall be provided, located on bottom of unit.
 2. Coil handing shall be specified as [right hand] or [left hand] when looking into the coil inlet in the direction of airflow.
 3. The water coil shall be supplied with an access door located:
 - a. Upstream of the water coil in the terminal casing.
 - b. Downstream of the water coil in a common casing with the coil.
 4. The water coil access door shall be secured to the casing with:
 - a. Quarter turn sash latches.
 - b. The water coil fins shall be 0.0045 inch aluminum fins, mechanically-bonded to seamless 0.50 by 0.016 inch copper tubes.
 1. Fins shall be formed in a high heat transfer sine wave configuration.
 2. Standard coil shall be a 10 fins-per-inch fin construction.
 3. High capacity coil shall be a 12 fins-per-inch fin construction.

- c. All water coils shall be hydrostatically tested to a minimum 390 pounds per square inch, with a minimum burst pressure of 1800 pounds per square inch at ambient temperature. All water coils are rated for a maximum of 300 pounds per square inch working pressure at 200 degrees Fahrenheit.
 - d. The water coil shall be certified in accordance with AHRI 410 and units shall bear an AHRI 410 label.
 - 1. An optional oversized casing shall be upsized to increase heat transfer with low supply water temperatures while reducing air side pressure drop.
- 1. Control Transformers:
 - a. The terminal unit shall be supplied with a factory mounted 50 VA control transformer.
- 2. Low Leakage Construction:
 - a. The terminals shall be provided with factory certified low leakage construction up to three inches water gauge internal pressure.
 - b. Inlet dampers shall exhibit leakage rates of less than:
 - 1. 1% of maximum nominal catalog airflow for CLL6
 - c. Single duct casings shall exhibit external leakage rates of less than:
 - 1. 1% of maximum nominal catalog airflow for CLL3
 - d. Terminals with low leakage construction shall include the following design features:
 - 1. The access door shall be supplied with compression style gasketing and quarter turn latches.
 - 2. The unit casing shall be flanged and gasketed at all external casing seams.
 - 3. All production units shall be individually factory tested to ensure compliance with project specific leakage requirements.
 - 4. Leakage test results shall be documented on a label affixed to each certified low leakage unit.
- G. Electrical Requirements:
 - 1. Single duct terminal units shall be provided with single-point power connection.
 - 2. The terminal unit equipment wiring shall comply with the requirements of NFPA 70.
- H. Controls:
 - 1. See Section 23 09 13 - Instrumentation and Control Devices for HVAC: Thermostats and actuators for controls requirements.
- I. Controls Sequence:
 - 1. See Section 23 09 93 - Sequence of Operations for HVAC Controls for controls sequence requirements.

2.2 DEHUMIDIFIERS

- A. Description:
 - 1. Furnish and install single duct terminal units in the sizes and configurations as indicated on the plans.
 - 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following"
 - a. Alorair Model Sentinel HDi65 (Basis of Design)
 - b. Aprilaire Model E

- c. Santa Fe Model Compact70
- d. Or equal as approved by the Professional

B. Specifications

- 1. Energy Star Compliant
- 2. Automatic Defrosting
- 3. Dual Drainage Options (gravity or heavy-duty condensate pump)
- 4. Precise automatic humidistat control
- 5. Current: 4.1 A
- 6. Size/Coverage: Up to 1,300 Sq. Ft.
- 7. Noise Level: <52 dBA
- 8. Capacity: 120 ppd (Saturation 90°F - 90%), 55 ppd (AHAM 80°F - 60%)
- 9. Airflow: 130 CFM, 230 CMH
- 10. Dimensions (LxWxH): 19.2" x 12.2" x 13.3"
- 11. Refrigerant: R410A
- 12. COP: 2.4 L/kWh
- 13. Power: 115 V/60 Hz
- 14. Filter: MERV-1
- 15. Draining: 19.6ft pump pipe drain and 6.5ft gravity drain pipe
- 16. Functioning Temperature Range: 33.8°F -104°F
- 17. Functioning Humidity Range: 36~90%
- 18. Weight: 44 lbs (20 kg)

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements
- B. Verify ductwork is ready for air terminal installation.

3.2 INSTALLATION

- A. Connect to ductwork in accordance with Section 23 31 00.
- B. Install ceiling access doors or locate units above easily removable ceiling components.
- C. Support units individually from structure. Do not support from adjacent ductwork.
- D. Support air terminal units connected by flexible duct independently of flexible duct.
- E. Install transition piece to match flexible duct size to inlet or outlet of variable air volume terminal.

3.3 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements.
- B. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to 0 percent full flow.

END OF SECTION 233600

SECTION 23 37 00

AIR OUTLETS AND INLETS

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. Square Ceiling Plaque Supply Diffuser (CD-1 & CD-2)
 - 2. Square Louvered Diffusers (CD-3 & CD-4)
 - 3. Surface Mounted Supply Grille (SG-1)
 - 4. Ceiling Exhaust and Return Grille (RG-1)
 - 5. Surface Mounted Return Grille (RG-2)
 - 6. Steel Louvered Exhaust Grille (EG-1)
 - 7. SS Louvered Exhaust and Return Grille (EG-2)
 - 8. Maximum Security Supply Grille (MSSG-1)
 - 9. Maximum Security Return Grille (MSRG-1)
- B. Related Sections:
 - 1. Section 08 91 00 - Louvers: Wall Louvers.
 - 2. Section 09 90 00 - Painting and Coating: Execution and product requirements for Painting of ductwork visible behind outlets and inlets specified by this section.
 - 3. Section 23 09 00 - Instrumentation and Control for HVAC: Operators for adjustable louvers.
 - 4. Section 23 09 23 - Direct-Digital Control System for HVAC: Operators for adjustable louvers.
 - 5. Section 23 33 00 - Air Duct Accessories: Volume dampers for inlets and outlets.

1.3 REFERENCES

- A. Air Movement and Control Association International, Inc.:
 - 1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets.
- C. Sheet Metal and Air Conditioning Contractors:
 - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit sizes, finish, and type of mounting. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
- C. Furnish five year manufacturer warranty for air outlets and inlets.

PART 2 PRODUCTS

- 2.1 Manufacturers Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
- A. Price Industries (Model type listed under each section) (Basis of Design)
 - B. Nailor
 - C. Greenheck
 - D. Ruskin
 - E. Or equal as approved by the Professional
- 2.2 SQUARE CEILING PLAQUE SUPPLY DIFFUSER (CD-1 & CD-2)
- A. Description:
1. Furnish and install Price model SPD/ASPD – steel/Aluminum square plaque ceiling diffusers in all ceiling tile spaces, other than showers/bathrooms. Furnish and install Price model ASPD – aluminum square plaque ceiling diffusers in all ceiling tile spaces of showers/bathrooms. Sizes and mounting types designated by the plans and air distribution schedule.
- B. Construction:
1. Diffusers shall be steel or aluminum construction, as scheduled, and shall consist of a seamless, one-piece, precision formed backpan that incorporates a round inlet collar of sufficient length for connecting rigid or flexible duct.
 2. An inner plaque assembly shall be incorporated and shall drop no more than ¼ inch below the ceiling plane to assure proper air distribution performance.
 3. The inner plaque assembly shall be completely removable from the room side to allow for full access to any dampers or other ductwork components located near the diffuser neck.
 4. The diffuser shall integrate with all duct sizes shown on the plans without affecting the face size and appearance of the unit.
 5. The face panel shall have smooth edges and rounded corners to blend with the back cone.
 6. The diffuser ceiling module size shall be as scheduled:
 - a. 24 x 24 inches
- C. Paint Specification:
1. Paint finish shall be:
 - a. All components shall have a baked-on powder coat finish.
 1. The paint finish must demonstrate no degradation when tested in accordance with ASTM D1308 (covered and spot immersion) and ASTM D4752 (MEK double rub) paint durability tests.
 2. The paint film thickness shall be a minimum of 2.0 mils.
 3. The finish shall have a hardness of 2H.
 4. The finish shall withstand a minimum salt spray exposure of 500 hours with no measurable creep in accordance with ASTM D1654, and 1000 hours of exposure with no rusting or blistering as per ASTM D610 and ASTM D714.
 5. The finish shall have an impact resistance of 80 inch-pounds.
- D. Mounting Frame:
1. The diffuser mounting frame shall be suitable for lay-in or surface mount applications with the following frame style:
 2. 15/16 inch wide flat T-bar

E. Options:

1. Insulated Back pan:
 - a. R6 – The diffuser back pan shall be externally insulated with a molded heavy duty foil/scrim vapor barrier with an R-value of six. The insulation shall meet the requirements of UL 181 and NFPA 90A.
2. Steel Panel:
 - a. The diffuser shall be mounted in a steel panel for lay-in applications 24x24.
 - b. The panel size shall be based on the diffuser size scheduled.
3. Damper:
 - a. The diffuser shall be supplied with a steel volume control damper:
 1. Full flow damper, diffuser mounted (VCR8E), fine-tuning of airflow only, branch duct volume damper to be used for balancing.

2.3 SQUARE LOUVERED DIFFUSER (CD-3 & CD-4)

A. Description:

1. Furnish and install Price Models [SMX/AMX], modular louvered face ceiling diffusers of sizes, discharge patterns, and mounting types designated by the plans and air distribution schedule.

B. Construction:

1. Diffusers shall be steel construction.
2. The diffuser shall consist of:
 - a. An outer frame assembly, which facilitates mounting in the application shown in the project plans.
 - b. An integral collar that allows connection to the [square] or [rectangular] duct.
 - c. An inner core assembly consisting of fixed louvers capable of producing the airflow discharge pattern as indicated on the project plans, and shall be fully removable from the installed diffuser frame for access to any dampers or other ductwork components located in or near the diffuser neck.
3. The inner core assemblies shall be identically constructed so that directional core assemblies providing different airflow discharge patterns may be interchanged between frames if the frame duct connections are the same size.

4.

C. Paint Specification:

1. Paint finish shall be as scheduled:
 - a. The diffuser face shall have a baked-on powder coat finish.
 1. The paint finish must demonstrate no degradation when tested in accordance with ASTM D1308 (covered and spot immersion) and ASTM D4752 (MEK double rub) paint durability tests.
 2. The paint film thickness shall be a minimum of 2.0 mils.
 3. The finish shall have a hardness of 2H.
 4. The finish shall withstand a minimum salt spray exposure of 1000 hours with no measurable creep in accordance with ASTM D1654, and 1000 hours of exposure with no rusting or blistering as per ASTM D610 and ASTM D714.
 5. The finish shall have an impact resistance of 80 inch-pounds.

D. Mounting Frame:

1. The diffuser shall be supplied with a frame as scheduled:
 - a. Surface mount with beveled frame (CD-4).
 - b. 15/16 inch wide flat T-bar (CD-3).
- E. Options as scheduled:
 1. High Induction Vanes:
 - a. The diffuser shall be supplied with internally mounted discharge vanes to create a high rate of induction to rapidly mix room and supply air.
 2. Damper and Square to Round Adaptor:
 - a. The diffuser shall be supplied with an aperture style volume flow damper. The damper shall be manually adjustable from the diffuser face.
 - b. The diffuser shall be supplied with a square to round adaptor to connect to round duct as required.
 3. Insulation:
 - a. R6 – The diffuser back pan shall be externally insulated with a molded heavy duty foil/scrim vapor barrier with an R-value of six. The insulation shall meet the requirements of UL181 and NFPA 90A.
- 2.4 SURFACE MOUNTED SUPPLY GRILLE (SG-1)
 - A. Description:
 1. Furnish and install Price Model 520/S-N steel louvered supply grilles and registers of sizes and mounting types designated by the plans and air distribution schedule.
 - B. Construction:
 1. The grille blades and border shall be steel construction.
 2. Grilles shall be or louver type, and shall have:
 - a. Two sets of fully adjustable blades with 3/4 inch on center blade spacing.
 3. The grilles front blade orientation shall be, as indicated on the outlet schedule.
 - a. Front blades parallel to the long dimension.
 - C. Paint Specification:
 1. Paint finish shall be:
 - a. All components shall have a baked-on powder coat finish.
 1. The paint finish must demonstrate no degradation when tested in accordance with ASTM D1308 (covered and spot immersion) and ASTM D4752 (MEK double rub) paint durability tests.
 2. The paint film thickness shall be a minimum of 2.0 mils.
 3. The finish shall have a hardness of 2H.
 4. The finish shall withstand a minimum salt spray exposure of 1000 hours with no measurable creep in accordance with ASTM D1654, and 1000 hours of exposure with no rusting or blistering as per ASTM D610 and ASTM D714.
 5. The finish shall have an impact resistance of 80 inch-pounds.
 - D. Options:
 1. Opposed Blade Damper:
 - a. The register shall be supplied with a coated steel opposed blade damper. The damper shall be operable from the register face.
 2. Border Style:

- a. The grille shall be suitable for surface/duct frame mount, complete with a border in the following style:
 - 1. 1 inch narrow frame.
 - 3. Mounting Frame
 - a. The grille shall be supplied with:
 - 1. 3/8 inch flat border mounting frame.
 - 4. Fastening:
 - a. The grille shall be supplied with the following fastening method:
 - 1. Countersunk screw holes complete with screws.
- 2.5 Steel Louvered Return Grille (RG-1)
- A. Description:
 - 1. Furnish and install Price Model 530, steel louvered return grilles and registers of sizes and mounting types designated by the plans and air distribution schedule.
 - B. Construction:
 - 1. The grille blades and border shall be steel construction.
 - 2. Grilles shall be 45 degree deflection fixed louver type to minimize see-through, and shall have:
 - a. One set of fixed blades with 3/4 inch on center blade spacing Model 530
 - 3. The grilles blade orientation shall be (select one), as indicated on the outlet schedule.
 - a. Blades parallel to the long dimension.
 - b. Blades parallel to the short dimension.
 - C. Paint Specification:
 - 1. Paint finish shall be (select one):
 - a. Baked-on powder coat finish.
 - 1. The paint film thickness shall be a minimum of 2 mils.
 - 2. The finish shall have a hardness of 2H as tested in accordance with ASTM D3363.
 - 3. The finish shall pass an ASTM B117 Corrosive Environment Salt Spray Test for 1000 hours with no measurable creep, rusting or blistering as per ASTM D1654, D610 and D714.
 - 4. The finish shall pass an ASTM D870 Water Immersion test of a minimum of 500 hours with no measurable with no rusting or blistering as per ASTM D610 and D714.
 - 5. The finish shall have an impact resistance of 100 inch-pounds in accordance with ASTM D2794.
 - b. All components shall have a custom finish in a color to match a customer supplied sample.
 - D. Options:
 - 1. Opposed Blade Damper:
 - a. The register shall be supplied with a coated steel (D) opposed blade damper. The damper shall be operable from the register face.
 - 2. Border Style:
 - a. The grille shall be suitable for T-bar lay-in mounting, complete with a border in the following style:
 - 1. Panel mount border. The maximum grille size shall equal the module size minus four inches. The panel module shall be the following size:
 - a. 24 x 24 inches.
 - 3. Mounting Frames:
 - a. The grille shall be supplied with:

1. 5/8 inch narrow border mounting frame.
4. Fastening:
 - a. The grille shall be supplied with the following fastening method (select one):
 1. No screw holes (default for T-bar frames).

2.6 SURFACE MOUNTED RETURN GRILLE (RG-2)

A. Description:

1. Furnish and install Price Model 520L steel louvered supply grilles and registers of sizes and mounting types designated by the plans and air distribution schedule.

B. Construction:

1. The grille blades and border shall be steel construction.
2. Grilles shall be single deflection louver type, and shall have:
 - a. One set of fully adjustable blades, with 3/4 inch on center blade spacing.
3. The grilles front blade orientation shall be, as indicated on the outlet schedule.
 - a. Front blades parallel to the long dimension.

C. Paint Specification:

1. Paint finish shall be:
 - a. All components shall have a baked-on powder coat finish.
 1. The paint finish must demonstrate no degradation when tested in accordance with ASTM D1308 (covered and spot immersion) and ASTM D4752 (MEK double rub) paint durability tests.
 2. The paint film thickness shall be a minimum of 2.0 mils.
 3. The finish shall have a hardness of 2H.
 4. The finish shall withstand a minimum salt spray exposure of 1000 hours with no measurable creep in accordance with ASTM D1654, and 1000 hours of exposure with no rusting or blistering as per ASTM D610 and ASTM D714.
 5. The finish shall have an impact resistance of 80 inch-pounds.

D. Options:

1. Opposed Blade Damper:
 - a. The register shall be supplied with a coated steel opposed blade damper. The damper shall be operable from the register face.
2. Border Style:
 - a. The grille shall be suitable for surface/duct mounting, complete with a border in the following style:
 1. 1 inch narrow frame.
3. Mounting Frames:
 - a. The grille shall be supplied with:
 1. 3/8 inch flat border mounting frame.
4. Fastening:
 - a. The grille shall be supplied with the following fastening method:
 1. Countersunk screw holes complete with screws.

2.7 STEEL LOUVERED EXHAUST GRILLE (EG-1)

A. Description:

1. Furnish and install Price Model 530 steel louvered return grilles and registers of sizes and mounting types designated by the plans and air distribution schedule.
- B. Construction:
1. The grille blades and border shall be steel construction.
 2. Grilles shall be 45 degree deflection fixed louver type to minimize see-through, and shall have:
 - a. One set of fixed blades with 3/4 inch on center blade spacing Model 530
 3. The grilles blade orientation shall be, as indicated on the outlet schedule.
 - a. Blades parallel to the long dimension.
- C. Paint Specification:
1. Paint finish shall be:
 - a. All components shall have a baked-on powder coat finish.
 1. The paint finish must demonstrate no degradation when tested in accordance with ASTM D1308 (covered and spot immersion) and ASTM D4752 (MEK double rub) paint durability tests.
 2. The paint film thickness shall be a minimum of 2.0 mils.
 3. The finish shall have a hardness of 2H.
 4. The finish shall withstand a minimum salt spray exposure of 1000 hours with no measurable creep in accordance with ASTM D1654, and 1000 hours of exposure with no rusting or blistering as per ASTM D610 and ASTM D714.
 5. The finish shall have an impact resistance of 80 inch-pounds.
- D. Options:
1. Opposed Blade Damper:
 - a. The register shall be supplied with a coated steel (D) opposed blade damper. The damper shall be operable from the register face for fine-tuning only.
 2. Border Style:
 - a. The grille shall be suitable for T-bar lay-in mounting, complete with a border in the following style:
 1. Panel mount border. The maximum grille size shall equal the module size minus four inches. The panel module shall be the following size:
 - a. 24 x 24 inches.
 3. Mounting Frames:
 - a. The grille shall be supplied with:
 1. 5/8 inch narrow border mounting frame.
 4. Fastening:
 - a. The grille shall be supplied with the following fastening method:
 1. No screw holes (default for T-bar frames).
- 2.8 SS LOUVERED EXHAUST AND RETURN GRILLE (EG-2)
- A. Description:
1. Furnish and install Price Model 735 stainless steel louvered return grilles and registers of sizes and mounting types designated by the plans and air distribution schedule.
- B. Construction:
1. Grilles shall be fixed louver type, and shall have:

- a. One set of fixed blades at 45 degree deflection with 1/2 inch on center blade spacing Model 735.
 - 2. The grilles front blade orientation shall be, as indicated on the outlet schedule.
 - a. Front blades parallel to the long dimension.
 - 3. The blades and border shall be stainless steel construction.
 - 4. The grille shall use a continuous length piano type hinge and quarter turn quick-release fasteners for access.
 - 5. The minimum grille size shall be six inches by four inches. The maximum one-piece grille size shall be 48 inches x 48 inches.
 - 6. The grille shall be supplied with a mullion when nominal grille dimensions exceed 20 inches.
- C. Finish:
- 1. The grille blade finish shall be 2B stainless steel.
- D. Options:
- 1. Opposed Blade Damper:
 - a. The register shall be supplied with a mill finish stainless steel (DSS) opposed blade damper for fine-tuning only.
 - 2. Border Style:
 - a. The grille shall be suitable for surface mounting.
 - 3. Mounting Frames:
 - a. The grille shall be supplied with a 3/8 inch flat border mounting frame.
 - 4. Fastening:
 - a. The grille shall be supplied with the following fastening method (select one):
 - b. Countersunk screw holes complete with screws.

2.9 MAXIMUM SECURITY SUPPLY GRILLE (MSSG-1)

- A. Furnish and install Price model MSRRCD maximum security risk resistant ceiling diffuser of the sizes, discharge patterns and mounting types indicated on the plans and outlet schedule. The diffuser shall be constructed of 12 gauge hot rolled steel. Louver blades shall be spaced for 5/16 in. channel width at the diffuser face, with a 35 degree air discharge angle. The louvers shall be fixed in place and shall follow a zigzag pattern through the diffuser. The diffuser shall be painted with a powder coat process and finished in white. Paint finish shall pass 500 hours of salt spray exposure with no measurable creep in accordance with ASTM D1654 and 1000 hours with no rusting or blistering as per ASTM D610 and ASTM D714.

2.10 MAXIMUM SECURITY RETURN GRILLE (MSRG-1)

- A. Furnish and install Price model MSGS steel maximum security return straight fixed louver grilles with steel rods of the sizes and mounting types indicated on the plans and outlet schedule. Grilles shall be 0 degree deflection fixed louver type with blades spaced 1/4 in. on center supported by hardened steel rods located on 6 in. centers. The face frame shall be 3/16 in. hot rolled steel. Blades shall run parallel to the long dimension of the grille. The grille is to be attached to a 12 gauge hot rolled steel wall sleeve with a rear mounting frame for a concealed and secure fastening. The grille shall be painted with a powder coat process and be finished in white. Paint finish shall pass 500 hours of salt spray exposure with no measurable creep in accordance with ASTM D1654 and 1000 hours with no rusting or blistering as per ASTM D610 and ASTM D714.

- B. Optional integral volume control damper shall be of the opposed blade type and shall be constructed of cold rolled steel. The damper shall be mounted in the wall sleeve and be operable from the front of the register for fine-tuning only.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify inlet and outlet locations.
- C. Verify ceiling systems are ready for installation.

3.2 INSTALLATION

- A. Install diffusers to ductwork with airtight connection.
- B. Install balancing dampers on duct take-off to diffusers, grilles, and registers, whether or not dampers are furnished as part of diffuser, grille, and register assembly. Refer to Section 23 33 00.
- C. Paint visible portion of ductwork behind air outlets and inlets matte black. Refer to Section 09 90 00.

3.3 INTERFACE WITH OTHER PRODUCTS

- A. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

END OF SECTION 233700

SECTION 23 51 00

BREECHINGS, CHIMNEYS, AND STACKS

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. This Section includes the following:
 - 1. Building-heating-appliance chimneys.
- B. Related Sections include the following:
 - 1. Section 235113 "Draft Control Devices" for induced-draft and mechanical fans and for motorized and barometric dampers.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Building-heating-appliance chimneys.
- B. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers, and location and size of each field connection.

1.5 INFORMATIONAL SUBMITTALS

- A. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain listed system components through one source from a single manufacturer.
- B. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

PART 2 - PRODUCTS

2.1 LISTED BUILDING-HEATING-APPLIANCE CHIMNEYS

- 2.2 Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

- A. The Schebler Company – Model P2A (Basis of Design)
- B. Selkirk
- C. CaptiveAire
- D. Or equal as approved by the Professional

2.3 Description:

- A. The factory built modular chimney shall be laboratory tested and listed with Underwriters Laboratories Standard UL 103 Standard for Factory-Built Chimneys for Building Heating Appliances, UL 2561, Standard for 1400°F Degree Fahrenheit Factory-Built Chimneys for use with building heating equipment burning gas, solid or liquid fuels with flue gases not exceeding 1400°F continuous operations and 1800°F intermittent operation. The vent sections shall be sealed by use of a ½" flange to flange connection and sections shall be coupled using RapidLock™ bands and joint sealant.

2.4 Construction:

- A. Between the inner and outer shells there shall have a minimum 2" with a 1" air gap of 1600°F rated low conductivity ceramic fiber insulation. The insulation is to be securely attached to the inner shell with steel straps and insulating pins welded to the inner shell. Stainless steel centering clips shall be welded to the outer shell to maintain the required spacing and ensure concentricity of the shells.

2.5 Inner Shell:

- A. ASTM A 666, Type 304 stainless steel for natural gas and number 2 oil fired appliances, type 316 stainless steel for coal, number 4 and number 6 oil fired appliances. Inner shell thickness shall be .036" for 6" to 36" diameter systems and .048" for 38" to 48" diameter systems. All inner shell seams shall be full penetration welded the entire length of the pipe section. Riveted, tack or spot-welded seams are not permitted.

2.6 Outer Jacket:

- A. Outer shell material shall be type 430 stainless steel with a thickness of .028" for 5" to 36" diameter systems and .048" for 38" to 48" diameter systems. All outer shell seams shall be full penetration welded the entire length of the pipe section. Riveted, tack or spot-welded seams are not permitted.

2.7 Accessories:

- A. 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.

2.8 Termination:

- A. Round chimney top designed to exclude minimum 98 percent of rainfall.

2.9 Special Warranty:

- A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, structural failures caused by expansion and contraction.

2.10 Warranty Period:

- A. Extended (10) years from date of Substantial Completion. System sizing and design has been performed by Schebler personnel and design parameters provided to the Schebler Company by the responsible engineer were and are accurately representative of the operating conditions. The undamaged components have been correctly installed in accordance with the installation instructions published by the manufacturer.

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.

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

3.2 APPLICATION

- A. Listed Building-Heating-Appliance Chimneys: Dual-fuel boilers and water heaters

3.3 INSTALLATION OF LISTED VENTS AND CHIMNEYS

- A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
- B. Seal between sections of positive-pressure vents according to manufacturer's written installation instructions, using sealants recommended by manufacturer.
- C. Slope breechings down in direction of appliance.
- D. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
- E. Connect base section to foundation using anchor lugs of size and number recommended by manufacturer.

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.
- B. Clean breechings internally, during and after installation, to remove dust and debris.
- C. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION 235100

SECTION 23 52 23

CAST-IRON BOILERS

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. Cast-iron boilers.
 - 2. Boiler controls.

- B. Related Requirements:

- 1. Section 033000 - Cast-in-Place Concrete: Requirements for concrete housekeeping pads.
 - 2. Section 221100 - Facility Water Distribution: Cold water piping connections to boilers.
 - 3. Section 230513 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors for placement by this Section.
 - 4. Section 230548 - Vibration and Seismic Controls for HVAC: Product requirements for vibration isolators for placement by this Section.
 - 5. Section 230593 - Testing, Adjusting, and Balancing for HVAC: Adjusting and balancing hot water boiler flow rates.
 - 6. Section 231123 - Facility Natural-Gas Piping: Requirements for natural gas piping connections to boilers.
 - 7. Section 232113 - Hydronic Piping: Requirements for hot water piping for connection to boilers.
 - 8. Section 232500 - HVAC Water Treatment: Requirements for system cleaner, closed-loop treatment, and steam treatment.
 - 9. Section 235100 - Breechings, Chimneys, and Stacks: Requirements for breeching, chimney, and stack connections to boilers.
 - 10. Section 260583 - Wiring Connections: Electrical connections to boilers.

1.3 REFERENCE STANDARDS

- A. Air-Conditioning, Heating, and Refrigeration Institute - Hydronics Institute Section:

- 1. AHRI 1500 - Performance Rating of Commercial Space Heating Boilers.

- B. American National Standards Institute:

- 1. ANSI Z21.13 - Gas-Fired Low Pressure Steam and Hot Water Boilers.

- C. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE/IES 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

D. ASME International:

1. ASME Boiler and Pressure Vessel Code (BPVC) Section I - Rules for Construction of Power Boilers.
2. ASME BPVC Section IV - Heating Boilers.
3. ASME BPVC Section VIII, Division 1 - Rules for Construction of Pressure Vessels.
4. ASME CSD-1 - Controls and Safety Devices for Automatically Fired Boilers.

E. Department of Energy:

1. 10 CFR 430, Subpart B, Appendix N - Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers.

F. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

G. NFPA:

1. NFPA 31 - Standard for the Installation of Oil-Burning Equipment.
2. NFPA 54 - National Fuel Gas Code.
3. NFPA 58 - Liquefied Petroleum Gas Code.

H. UL:

1. UL 726 - Oil-Fired Boiler Assemblies.
2. UL 795 - Commercial-Industrial Gas Heating Equipment.

1.4 PREINSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Requirements for preinstallation meeting.
- B. Convene minimum one week prior to commencing Work of this Section.

1.5 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Requirements for submittals.
- B. Product Data:
 1. Submit manufacturer information for capacities, accessories, general layout, dimensions, electrical characteristics, weight, and mounting loads.
 2. Submit sizes and location of water fuel, electrical, and vent connections.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Test and Evaluation Reports:
 1. Indicate that boilers meet or exceed specified performance and efficiency.
 2. Submit results of testing.

- E. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.
- F. Source Quality-Control Submittals: Indicate results of factory tests and inspections.
- G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- H. Manufacturer Reports:
 - 1. Certify that equipment has been installed according to manufacturer instructions.
 - 2. After startup, indicate equipment control settings and performance chart of control system.
- I. Qualifications Statements:
 - 1. Submit qualifications for manufacturer and installer.
 - 2. Submit manufacturer's approval of installer.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Requirements for maintenance materials.
- B. Extra Stock Materials: Furnish one set of circulator pump seals.

1.7 QUALITY ASSURANCE

- A. Boiler Construction:
 - 1. Comply with ASME BPVC I, BPVC IV and ANSI Z21.13 UL 726.
 - 2. Furnish boilers registered with National Board of Boiler and Pressure Vessel Inspectors.
- B. Boiler Performance Requirements:
 - 1. Minimum Efficiency: Comply with ASHRAE/IES 90.1.
 - 2. Testing: Comply with AHRI 1500 and certify to AHRI Commercial Boilers Certification Program.
 - 3. Minimum Efficiency: Comply with 10 CFR 430, Subpart B, Appendix N.
- C. Gas Train and Safety Controls: Comply with requirements of ASME CSD-1 [Factory Mutual] [Industrial Risk Insurers] [Improved Risk Mutual (IRM Insurance)].
- D. Unit Certification: [American Gas Association] [AHRI] [Intertek ETL] [UL 795].
- E. Internal Wiring of Factory-Wired Equipment: Comply with applicable code.
- F. Products Requiring Electrical Connection: Listed and classified by UL as suitable for purpose specified and as indicated.
- G. Perform Work according to Pennsylvania DGS standards.
- H. Maintain one copy copies of each standard affecting Work of this Section on Site.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.
- B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store materials according to manufacturer instructions.
- D. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 - 2. Provide additional protection according to manufacturer instructions.

1.10 EXISTING CONDITIONS

- A. Field Measurements:
 - 1. Verify field measurements prior to fabrication.
 - 2. Indicate field measurements on Shop Drawings.

1.11 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Requirements for warranties.
- B. Furnish one-year manufacturer's warranty for boilers.
- C. Furnish ten-year manufacturer's warranty for cast-iron sections.

PART 2 - PRODUCTS

2.1 CAST-IRON BOILERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Weil-McLain LBG-4-W Series 2 (Basis of Design)
 - 2. Velocity
 - 3. Smith
 - 4. Or equal as approved by the Professional

- B. Boiler construction
1. Boiler sections
 - a. To be field assembled (factory assembled for "P" and "A" boiler(s) with short draw rods between each adjacent section and sealed with sealing rope to assure a permanent gas-tight seal while allowing for expansion and contraction of the sections.
 - b. Sealing rope shall be visible when the sections are assembled, allowing for visual inspection for proper gas-tight seal.
 - c. Sealed watertight by elastomer sealing rings, not cast iron nipples. Each port opening is machined to mate with sealing ring between sections.
 - d. Provided with sufficient tapings to install required controls.
 2. Boiler(s)
 - a. Provided with cast-in air elimination to separate air from circulating water.
 - b. Designed with a low silhouette and horizontal draft hood to provide maximum headroom.
 - c. Designed to allow system supply and return piping from either the right- or left-hand side.
 - d. Shipped with insulated heavy gauge steel jacket(s) with durable powdered paint enamel finish. Jacket designed to be installed after connecting supply and return piping.
- C. Boiler foundation(s)
1. Installer shall construct required level concrete foundation(s) and support(s) where the boiler room floor is uneven or will not support the weight of the boiler(s) or where the boiler room may experience flooding.
- D. Electronic Control System
1. The boiler(s) shall be furnished with (an) electronic control system(s) with factory pre-wired control panel for each base assembly.
 2. The electronic control system(s) shall incorporate pilot valve, main valve, intermittent electronic pilot ignition, and pilot flame sensing operations in a single control module.
 3. The electronic control system(s) shall provide nominal fifteen (15) second flame response timing with five (5) minute lockout in the event the pilot flame is not proven.
 4. The electronic control system(s) safety pilot burner for each boiler-base assembly shall be intermittent burning and electrically ignited. The safety pilot burner and main burner flames shall be electronically supervised by flame rectification.
- E. Boiler trim
1. All electrical components to be of high quality and bear the UL label.
 2. Electrical wiring to utilize a labeled and color-coded wiring harness to help assure correct wiring.
 3. Water boiler(s) standard controls furnished:
 - a. Combination high and operating temperature limit control. (240 degrees F maximum allowable water temperature) Operating limit shall have adjustable differential.
 - b. Combination pressure-temperature gauge. Dial clearly marked and easy to read.
 - c. A.S.M.E. certified pressure relief valve, set to relieve at 30 PSIG. Side outlet discharge type; installer to pipe outlet to floor drain or near floor. Optional relief valves shall be available with set point up to and including maximum allowable pressure. Optional relief valve to be specified when ordered.
 - d. Transformer rated for 75VA.
 - e. "P" units only: Low water cut-off (LWCO). LWCO shall be electrode type capable of shutting down the boiler in event of a low water situation.
- F. Optional Components
1. The boiler(s) shall be able to be provided with up to two optional inspection openings on each section.

- a. Inspection opening(s) shall be 1½" in diameter and shall be provided with brass plugs.
- G. Boiler Manuals
 - 1. The boiler(s) shall be provided with complete instruction manuals, including:
 - a. Boiler Installation Manual
 - b. Gas Control Supplement
 - c. User's Information Manual
- H. ASME CSD-1 Modifications
 - 1. Boiler(s) specified to meet the requirements of ASME CSD-1 shall meet all of the above specifications with the following modifications:
 - 2. Replace Section II.E.3 above with the following:
 - a. Water boiler(s) ASME CSD-1 controls furnished: (ASME CSD-1 not available on size LGB-5 boiler(s))
 - 1) Combination high and operating temperature limit control. (240 degrees F maximum allowable water temperature) Operating limit shall have adjustable differential.
 - 2) Additional high temperature limit control with manual reset. (250 degrees F maximum allowable water temperature)
 - 3) Low water cut-off (LWCO) with manual reset. LWCO shall be electrode type capable of shutting down the boiler in event of a low water situation.
 - 4) Combination pressure-temperature gauge. Dial clearly marked and easy to read.
 - 5) A.S.M.E. certified pressure relief valve, set to relieve at 30 PSIG. Side outlet discharge type; installer to pipe outlet to floor drain or near floor.
 - 6) Transformer rated for 75VA.
- I. Industrial Risk Insurance (I.R.I.) Modifications
 - 1. Boiler(s) specified to meet the requirements of I.R.I. shall meet all of the above specifications with the following modifications
 - 2. Replace Section II.E.3 above with the following:
 - a. Water boiler(s) I.R.I. controls furnished: (*Sizes LGB 5-23 only*)
 - 1) Combination high and operating temperature limit control. (240 degrees F maximum allowable water temperature) Operating limit shall have adjustable differential.
 - 2) Additional high temperature limit control with manual reset. (250 degrees F maximum allowable water temperature)
 - 3) Low water cut-off (LWCO). LWCO shall be electrode type capable of shutting down the boiler in event of a low water situation.
 - 4) Combination pressure-temperature gauge. Dial clearly marked and easy to read.
 - 5) A.S.M.E. certified pressure relief valve, set to relieve at 30 PSIG. Side outlet discharge type; installer to pipe outlet to floor drain or near floor.
 - 6) Transformer rated for 75VA (not used on size LGB 5-12 boiler(s)).
- J. Factory Mutual (F.M.) Modifications
 - 1. Boiler(s) specified to meet the requirements of F.M. shall meet all of the above specifications with the following modifications:

PART 3 - EXECUTION

3.1 INSTALLATION

- A. According to manufacturer instructions.
- B. Assemble boiler from knockdown configuration after transporting into boiler room.
- C. Install boilers plumb and level, to plus or minus 1/16 inch over boiler base.
- D. Maintain manufacturer's recommended clearances around and over boilers.
- E. Housekeeping Pad:
 - 1. Material: Concrete, as specified in Section 033000 - Cast-in-Place Concrete.
 - 2. Minimum Size: 3-1/2 inches high and 6 inches larger than boiler base on each side.
- F. Vibration Isolators: As specified in Section 230548 - Vibration and Seismic Controls for HVAC.
- G. Hot Water Piping Connections: Connect to supply and return boiler connections.
- H. Fuel Piping Connections:
 - 1. Connect to boiler, full size of boiler gas train inlet.
 - 2. Arrange piping with clearances for burner removal and service.
 - 3. Natural-Gas Piping:
 - a. As specified in Section 231123 - Facility Natural-Gas Piping.
 - b. Comply with NFPA 54.
 - c. Accessories:
 - 1) Strainer.
 - 2) Pressure gage.
 - 3) Shutoff valve.
 - 4) Check valve.
 - 5) Pressure-reducing valve.
- I. Piping Accessories:
 - 1. As specified in Section 232113 - Hydronic Piping.
 - 2. On Supply:
 - a. Thermometer well for temperature controller.
 - b. Thermometer well and thermometer.
 - c. Well for [control system] temperature sensor.
 - d. Strainer.
 - e. Nipple and flow switch.
 - f. Pressure gage.
 - g. Shutoff valve.
 - 3. On Return:
 - a. Thermometer well and thermometer.
 - b. Well for [control system] temperature sensor.

- c. Pressure gage.
 - d. Shutoff valve.
 - e. Balancing valve.
- J. Install discharge piping from relief valves and drain valves to nearest floor drain.
- K. Circulator and Expansion Tank:
 - 1. Install on boiler.
 - 2. Pre-charge expansion tank to 12 psig.
- L. Install boiler trim, electrical devices, and accessories furnished loose for field mounting.
- M. Install control wiring between boiler control panel and field-mounted control devices.
- N. Connect flue to boiler outlet, full size of outlet.
- O. Install thermometer in boiler breeching within 12 inches of flue nozzle for cast-iron boilers, as specified in Section 235100 - Breechings, Chimneys, and Stacks.

3.2 FIELD QUALITY CONTROL

- A. Section 017000 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- B. Inspection:
 - 1. Arrange with local authorities having jurisdiction for inspection of boilers and piping.
 - 2. Obtain certificate of operation.
- C. Testing:
 - 1. Perform tests at minimum midrange and high-fire rates.
 - 2. Tests:
 - a. Boiler firing rate.
 - b. Over-fire draft.
 - c. Gas flow rate.
 - d. Heat input.
 - e. Burner manifold gas pressure.
 - f. Percent carbon monoxide.
 - g. Percent oxygen.
 - h. Percent excess air.
 - i. Flue-gas temperature at outlet.
 - j. Ambient temperature.
 - k. Net stack temperature.
 - l. Percent stack loss.
 - m. Percent efficiency.
 - n. Heat output.
- D. Knockdown Boilers Pressure Test:
 - 1. Pressure test before connecting natural gas piping, electrical connections, and controls.
 - 2. Install boiler drain and pressure gage.

3. Plug remaining openings.
 4. Fill boiler with water and vent air.
 5. Test Pressure:
 - a. Water Boilers: 1-1/2 times working pressure.
 - b. Maintain test pressure for 10 minutes with no leaks.
 6. Repair leaks and retest.
 7. After successful test, drain and remove plugs from openings to be used for piping connections and controls.
- E. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than 8 hours on Site for installation, inspection, startup, field testing, and instructing Owner's personnel in operation and maintenance of equipment.
- F. Equipment Acceptance:
1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
 2. Make final adjustments to equipment under direction of manufacturer's representative.
- G. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.3 ADJUSTING

- A. Section 017000 - Execution and Closeout Requirements: Requirements for starting and adjusting.
- B. Section 230593 - Testing, Adjusting, and Balancing for HVAC: Adjust and balance hot water boiler flow rates.
- C. Start up boilers according to manufacturer instructions and in presence of boiler manufacturer's representative.
- D. Test controls and demonstrate compliance with requirements.
- E. Adjust burner for maximum burning efficiency.
- F. Replace damaged or malfunctioning controls and equipment.

3.4 CLEANING

- A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Section 232500 - HVAC Water Treatment: Requirements for system cleaner, closed-loop treatment, and steam treatment.

3.5 DEMONSTRATION

- A. Section 017000 - Execution and Closeout Requirements: Requirements for demonstration and training.

- B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

3.6 MAINTENANCE

- A. Section 017000 - Execution and Closeout Requirements: Requirements for maintenance service.
- B. Provide service and maintenance of boilers for one year from date of Substantial Completion.
- C. Provide emergency callback service at all hours for specified maintenance period.
- D. Perform maintenance Work using qualified personnel under supervision original installer.

3.7 ATTACHMENTS

- A. Cast-Iron Boilers Schedule:
 - 1. Per Plans

END OF SECTION 235223

SECTION 23 73 00

AIR-TO-AIR ENERGY RECOVERY VENTILATOR UNITS

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 SECTION INCLUDES

- A. Air-to-Air Energy Recovery Ventilators (ERV)

1.03 RELATED SECTIONS

- A. Section 01 33 00 – Submittal Procedures
- B. Section 01 60 00 – Product Requirements
- C. Section 01 70 00 – Execution and Closeout Procedures
- D. Section 20 05 13 – Motor Requirements
- E. Section 23 09 00 – Instrumentation
- F. Section 23 09 93 – Sequence of Operation

1.04 REFERENCES

- A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. AMCA 99 - Standards Handbook.
- C. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.
- D. AMCA 300 - Test Code for Sound Rating Air Moving Devices.
- E. AMCA 500 - Test Methods for Louver, Dampers, and Shutters.
- F. ASTM B117 - Standard Practice for Operating Salt Spray Apparatus.
- G. NEMA MG1 - Motors and Generators.
- H. NFPA 70 - National Electrical Code.

- I. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- J. UL 723 - Test for Surface Burning Characteristics of Building Materials.
- K. UL 900 - Test Performance of Air Filter Units.
- L. UL 1995 - Standard for Heating and Cooling Equipment.
- M. UL 94 - Test for Flammability of Plastic Materials for Parts in Devices and Appliances.
- N. IBC 2000, 2003 - International Building Code.
- O. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
- P. NFPA 5000 - Building Construction and Safety Code.
- Q. ASHRAE 90.1 Energy Code.
- R. ARI Standard 1060 - Rating Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment.
- S. GSA 2003 Facilities Standard - 5.9 HVAC Systems and Components.

1.05 SUBMITTALS

- A. Submit under provisions of Section 01 33 00.
- B. Shop Drawings:
 - 1. Indicate assembly, unit dimensions, weight and point loads, required clearances, construction details, field connection details, and electrical characteristics and connection requirements. Computer generated fan curves for each unit shall be submitted with specific design operating point noted. Sound data for discharge, radiated, and return positions shall be submitted by octave band for each unit at rated capacity.
 - 2. Submit certified fan curves showing performance characteristics with fan and system operating point plotted and at variable speeds from design to minimum speed in 100 RPM increments.
 - 3. Product Data:
 - a. Provide detailed literature that includes unit construction, all material specifications, unit assembly, dimensions, weights, capacities, ratings, fan performance, sound levels at each frequency specified, motor specifications, finishes of materials, filter performance, filter racks, electrical characteristics, connection requirements, requirements on sealing unit penetrations, and recommended operation and maintenance.
 - b. Provide manufacturer's installation instructions.
 - c. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
 - d. Provide enthalpy plate performance data for summer and winter operation.
 - 2. Submittal Review
 - a. The A/E will review and stamp submittals in one of the following ways:

- b. "NO EXCEPTIONS TAKEN": Which means submittals are in general conformance with the design concept of the Project and in general compliance with the information given in the Contract Documents.
- c. "FURNISH AS CORRECTED": Which means submittals have minor corrections. Noted corrections must be made in the final installation. A/E has option to require resubmission for record.
- d. "REVISE AND RESUBMIT": Which means resubmission is required due to the nature or number of corrections.
- e. "REJECTED": Which means submittals do not meet contract requirements. Resubmission is required.
- f. Work may be executed under categories; "NO EXCEPTIONS TAKEN" or "FURNISH AS CORRECTED" only.

1.06 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 01 70 00.
- B. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.07 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Air Handler products specified in this section must show a minimum ten (10) years documented experience and complete catalog data on total product.

1.08 SAFETY AGENCY LISTED & CERTIFICATION

- A. Entire unit shall be UL 1812 or UL 1995 certified and bear certification label by ETL, UL, or CSA.
- B. Unit sound data shall be tested in accordance to AHRI 260.
- C. Manufacturer shall be able to provide evidence of independent testing of the core by Underwriters Laboratory (UL), verifying a maximum flame spread index (FSI) of 25 and a maximum smoke developed index (SDI) of 50 thereby meeting NFPA90A and NFPA 90B requirements for materials in a compartment handling air intended for circulation through a duct system. The method of test shall be UL Standard 723.
- D. The energy recovery cores used in these products shall be third party Certified by AHRI under its Standard 1060 for Energy Recovery Ventilators. AHRI published certifications shall confirm manufacturer's published performance for airflow, static pressure, temperature and total effectiveness, purge air (OACF) and exhaust air leakage (EATR). Products that are not currently AHRI certified will not be accepted. OACF shall be no more than 1.02 and EATR shall be at 0% against balanced airflow.
- E. Every unit to be factory tested prior to shipping: Motor Dielectric Voltage-Withstand Bench Test, Unit Dielectric Voltage-Withstand Test, Continuity of Internal Control Circuits Test, Unit Amperage Test

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 01 60 00.
- B. Deliver products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Manufacturer's representative, owner, engineer, and installing contractor shall visually review product for any visible damage on exposed surfaces. Any identified damages shall be replaced by the manufacturer at no cost.
- C. Materials shall be stored in a clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.
- D. Coordinate delivery, storage, and handling with owner's installing contractor.

1.10 EXTRA MATERIALS

- A. Provide one set of spare filters for each unit.

1.11 COORDINATION

- A. Manufacturer shall coordinate with and respond to the project engineer, owner's representative, prime contractor, general contractor, mechanical contractor, controls contractor, and electrical contractor throughout the duration of design and construction.
- B. Coordinate trap height requirements with project engineer and contractor.

1.12 WARRANTY

- A. The ERV core shall be warranted to be free of manufacturing defects and to retain its functional characteristics, under circumstances of normal use, for a period of ten (10) years from the date of purchase. The balance-of-unit shall be warranted to be free of manufacturing defects and to retain its functional characteristics, under circumstances of normal use, for a period of two (2) years from the date of installation.
- B. Manufacturer shall be able to provide evidence of independent testing of the core by Underwriters Refer to Section 20 05 13 for motor warranty requirements. The manufacturer's representative shall witness start-up.

PART 2 - PRODUCTS

2.01 OUTDOOR AIR-TO-AIR ENERGY RECOVERY VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. RenewAire (HE10RT) (Basis of Design)
 - 2. RenewAire
 - 3. Oxygen8
 - 4. Greenheck
 - 5. Or equal as approved by the Professional

B. MANUFACTURED UNITS

1. Air-to-Air Energy Recovery Ventilators shall be fully assembled at the factory and consist of a fixed-plate cross-flow heat exchanger with no moving parts, an insulated double wall ainted 20-gauge steel cabinet, motorized supply air damper, filter assemblies for both intake and exhaust air, enthalpy core, supply air blower assembly, motorized exhaust air damper, exhaust air blower assembly and electrical control box with all specified components and internal accessories factory installed and tested and prepared for single-point high voltage connection. Entire unit with the exception of field-installed components shall be assembled and test operated at the factory.

C. CABINET

1. Materials: Formed 1" double wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
2. Outside casing: 20 gauge, galvanized (G90) steel meeting ASTM A653 for components that do not receive a painted finish. Painted components as supplied by the factory shall have polyester urethane paint on 20 gauge G90 galvanized steel.
3. Access doors shall be 1" double wall hinged with airtight closed cell foam gaskets. Door pressure taps, with captive plugs, shall be provided for cross-core pressure measurement allowing for accurate airflow measurement.
4. Unit shall have factory-installed duct flanges on all duct openings.
5. Cabinet Insulation: Unit walls and doors shall be insulated with 1 inch, 4 pound density, foil/scrim faced, high density fiberglass board insulation, providing a cleanable surface and eliminating the possibility of exposing the fresh air to glass fibers, and with a minimum R-value of 6.5 (hr-ft²-°F/BTU).
6. Enthalpy core: Energy recovery core shall be of the total enthalpy type, capable of transferring both sensible and latent energy between airstreams. Latent energy transfer shall be accomplished by direct water vapor transfer from one airstream to the other, without exposing transfer media in succeeding cycles directly to the exhaust air and then to the fresh air. No condensate drains shall be allowed. The energy recovery core shall be designed and constructed to permit cleaning and removal for servicing. The energy recovery core shall have a ten year warranty. Performance criteria are to be as specified in AHRI Standard 1060.
7. Control center / connections: Energy Recovery Ventilator shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections to the fused disconnect.
8. Passive Frost Control: The ERV core shall perform without condensing or frosting under normal operating conditions (defined as outside temperatures above -10°F and inside relative humidity below 40%). Occasional more extreme conditions shall not affect the usual function, performance or durability of the core. No condensate drains will be allowed.
9. Motorized Isolation Damper(s): Exhaust Air motorized and Supply Air motorized damper(s) of an AMCA Class I low leakage type shall be factory installed.

D. FILTERS

1. Unit shall include 2" filter rack for the supply air and return air paths upstream of energy recovery exchanger. Filters shall be accessed through hinged filter access door. Supply one set of MERV 8 pleated filters for the Outdoor air stream and one set of MERV 8 for the Return air stream. All filters must be UL approved.
2. Provide factory mounted pressure sensors to measure filter pressure drop across pre-filter and main filter. Pressure drop shall be digitally feedback to controller for utilization in control and alarm sequencing. Unit controller shall monitor filter pressure level and report when filter changes are required.

E. BLOWER SECTION

1. Blower section construction, Supply Air and Exhaust Air: Blower assemblies consist of a 460V, 3 Phase, 60 HZ, TEFC motor, and a direct driven forward-curved blower. Provide with fused disconnect.
2. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.

F. MOTORS

1. Blower motors shall be Premium Efficiency, EISA compliant for energy efficiency. The blower motors shall be totally enclosed (TEFC) and shall be supplied with factory installed motor starters. Direct drive models shall be EISA-compliant for energy efficiency with open drip proof design and integral thermal protection.

G. UNIT ACOUSTICS

1. Acoustical performance shall be provided based on AHRI Standard 260 fan in unit testing. Provide units maximum sound power levels in dB, re 10-12 W as scheduled. Data provided in Sones or Bels is not acceptable.

H. ENERGY RECOVERY DEVICE

1. Where indicated, units shall include plate type cross flow heat exchanger fabricated from polymer membrane. Unit shall be capable of withstanding a maximum of 7.2" w.c. Maximum leakage between airstreams shall be 0.5% of nominal airflow.
2. The energy recover efficiency must be a minimum of 50% Total to meet ASHRAE 90.1.
3. The energy recovery device must have an ISO Hygiene rating of 0.
4. Energy recovery device shall be AHRI 1060 certified
5. Unit shall include a bypass damper with modulating actuator. Unit controller shall operate bypass dampers to maximize heat transfer without frosting and bypass heat exchanger during economizer mode.

I. PLASTIC COMPONENTS

1. All plastic components that are in the airstream, must be of a UL94 rated material.
2. If gasketing is used to join unit sections together, gasketing must be a UL94 approved compound.

J. CONTROLS

1. Fan control: Terminal strip for EC motors.
2. Bypass economizer control: Differential enthalpy control, 2 position dampers with 100% airflow through the core or 100% airflow bypassing the core.
3. Sensors: None.
4. Timeclock: Digital Time Clock mounting in outdoor, enclosed NEMA 3R enclosure, with up to 8 on/off cycles per day or 50 per week, 24VAC power, with battery backup protection of program settings against power failure to energize unit
5. Factory-installed microprocessor controller and sensors, Enhanced ERV controls that:
 - a. Comply with requirements in Division 23 Section "Sequence of Operations for HVAC Controls"
 - b. Has factory-installed hardware and software to enable the building automation interface via BACnet to monitor, control, and display status and alarms
 - c. The microprocessor controller shall be capable of operating at temperatures between -20F to 160F
 - d. The microprocessor controller shall be a DIN rail mounting type
 - e. Factory-installed microprocessor controller shall come with backlit display that allows menu-driven display for navigation and control of unit
 - f. The microprocessor controller shall have the ability to communicate with the BMS via BACnet MSTP/IP
 - g. The microprocessor controller shall have integrated ethernet interface and a web server for displaying unit parameters
 - h. The microprocessor shall have near field communication (NFC) capability for android devices
 - i. The microprocessor controller shall have an internal programmable time clock that will allow the user to add up to different occupancy schedules and add holidays
 - j. The microprocessor control shall be capable of integral diagnostics
 - k. The microprocessor control shall be capable of IP or SI unit display
 - l. The microprocessor controller shall have a battery powered clock
 - m. The microprocessor controller shall at a minimum offer the ability for three modes of determining occupancy: a dry contact, the internal time clock or the BMS
 - n. A remote user terminal to allow for remote monitoring and adjustment of parameters, allowing ease of control access without going outdoors or into the mechanical room if desired by the user
 - o. The microprocessor controller shall have at a minimum (10) universal inputs/outputs (AI, DI, AO) and have (6) six relay outputs (DO)

- p. The microprocessor controller shall have an integrated fieldbus port
- q. The microprocessor controller shall have the capability for I/O expansion
- r. The microprocessor controller shall have a micro USB port to load the application program, the unit parameters, saving logs, etc.
- s. The sensors that will be required for control are:
 - i. (2) Temperature sensor for fresh air and exhaust air
 - ii. (2) Temperature and humidity sensor for outside air, return air
 - iii. (2) Differential pressure sensors for filter alarms
 - iv. (2) Differential pressure sensors for measuring pressure drop across energy recovery core and for determining airflow in both airstreams
 - v. (2) Adjustable current switches
- t. The microprocessor controller shall have the capability to monitor the unit conditions for alarm conditions. Upon detecting an alarm, the microprocessor controller shall have the capability to record the alarm description, time, date, available temperatures, and unit status for user review. A digital output shall be reserved for remote alarm indication. Alarms to be also communicated via BMS as applicable. Provide the following alarm functions:
 - i. Outside air temperature sensor alarm
 - ii. Outside air humidity sensor alarm
 - iii. Return air temperature sensor alarm
 - iv. Return air humidity sensor alarm
 - v. Fresh air sensor alarm
 - vi. Exhaust air sensor alarm
 - vii. Dirty filter alarm
 - viii. Supply and exhaust air proving alarm
- u. Display the following on the face of microprocessor controller:
 - i. Unit on
 - ii. Unit economizer/bypass mode
 - iii. Outdoor air temperature
 - iv. Outdoor air humidity
 - v. Return air temperature

- vi. Return air humidity
- vii. Supply air temperature
- viii. Unit on/off
- ix. Fan on/off
- x. Damper status
- xi. Alarm digital display
- v. The microprocessor controller shall have factory pre-programmed multiple operating sequences for control of the ERV. Factory default settings shall be fully adjustable in the field. Available factory pre-programmed sequences on operations are:
 - i. Per the Sequence of Operation in section 23 09 93.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Prior to start of installation, examine area and conditions to verify correct location for compliance with installation tolerances and other conditions affecting unit performance. See unit IOM.
- B. Examine roughing-in of plumbing, electrical and HVAC services to verify actual location and compliance with unit requirements. See unit IOM.
- C. Proceed with installation only after all unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Installation shall be accomplished in accordance with these written specifications, project drawings, manufacturer's installation instructions as documented in manufacturer's IOM, Best Practices and all applicable building codes.
- B. Install unit with clearances for service and maintenance.

3.03 CONNECTIONS

- A. In all cases, industry Best Practices shall be incorporated. Connections are to be made subject to the installation requirements shown above.
- B. Duct installation and connection requirements are specified in Division 23 of this document.
- C. Electrical installation requirements are specified in Division 26 of this document.

3.04 FIELD QUALITY CONTROL

- A. Contractor to inspect field assembled components and equipment installation, to include electrical and piping connections. Report results to Architect/Engineer in writing. Inspection must include a complete startup checklist to include (as a minimum) the following: Completed Start-Up Checklists as found in manufacturer's IOM. Insert any other requirements here.

3.05 START-UP SERVICE

- A. Contractor to perform startup service. Clean entire unit, comb coil fins as necessary, and install clean filters. Measure and record electrical values for voltage and amperage. Refer to Division 23 "Testing, Adjusting and Balancing" and comply with provisions therein.

3.06 DEMONSTRATION AND TRAINING

- A. Contractor to train owner's maintenance personnel to adjust, operate and maintain the entire Make-Up Air unit. Refer to Division 01 Section Closeout Procedures and Demonstration and Training.

3.07 EQUIPMENT SCHEDULES

- A. Refer to Drawings

END OF SECTION 237200

SECTION 23 74 16

PACKAGED ROOFTOP AIR CONDITIONING UNITS

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. Packaged rooftop air conditioning unit.
 - 2. Roof curb.

- B. Related Sections:

- 1. Section 230923 - Direct-Digital Control System for HVAC: Controls remote from unit.
 - 2. Section 230993 - Sequence of Operations for HVAC Controls: Sequences of operation applying to units in this section.
 - 3. Section 231123 - Facility Natural-Gas Piping: Natural gas piping connections.
 - 4. Section 232113 - Hydronic Piping: Water and drain piping connections.
 - 5. Section 233300 - Air Duct Accessories: Flexible connections.

1.3 REFERENCES

- A. Air-Conditioning and Refrigeration Institute:

- 1. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
 - 2. ARI 340/360 - Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.

- B. Air Movement and Control Association International, Inc.:

- 1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

- C. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

- 1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
 - 2. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

- D. ASTM International:

- 1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.

E. National Electrical Manufacturers Association:

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA MG 1 - Motors and Generators.

F. National Fire Protection Association:

1. NFPA 54 - National Fuel Gas Code.
2. NFPA 58 - Liquefied Petroleum Gas Code.
3. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

1.4 DEFINITIONS

- A. Energy Efficiency Ratio (EER) - Ratio of net cooling capacity in Btuh to total rate of electric input in watts under designated operating conditions.
- B. Integrated Part-Load Value (IPLV): Single-number figure of merit based on part-load EER, COP, or kW/ton expressing part-load efficiency for air-conditioning and heat pump equipment on basis of weighted operation at various load capacities for the equipment.

1.5 OPERATION AND MAINTENANCE DATA

- A. Maintenance Data: Provide instructions for installation, maintenance and service

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience, who issues complete catalog data on total product.
- B. Startup must be done by trained personnel experienced with rooftop equipment.
- C. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters and remote controls are in place, bearings lubricated, and manufacturers' installation instructions have been followed.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site.
- B. Accept products on site and inspect for damage.
- C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

PART 2 - PRODUCTS

2.1 ROOFTOP AIR CONDITIONING UNITS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Daikin Applied (Basis of Design)
 - a. RTU-01: DPS010A
 - b. RTU-02: DPS003A
 - c. RTU-03: DPS010A
 - d. RTU-04: DPS004A
 - 2. Annexair
 - 3. Trane
 - 4. Or equal as approved by the Professional

2.2 GENERAL DESCRIPTION

- A. Furnish as shown on plans, Daikin Applied Rebel Single zone Heating and Cooling Unit(s) model DPS. Unit performance and electrical characteristics shall be per the job schedule.
- B. Configuration: Fabricate as detailed on prints and drawings:
 - 1. Return plenum / economizer section
 - 2. Filter section
 - 3. Cooling coil section
 - 4. Supply fan section
 - 5. Gas heating section
 - 6. Condensing unit section
- C. The complete unit shall be cETLus listed.
- D. The unit shall be ASHRAE 90.1-2016 compliant and labeled.
- E. Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Each unit shall be completely factory assembled and shipped in one piece. Packaged units shall be shipped fully charged with R-410 Refrigerant and oil.
- F. The unit shall undergo a complete factory run test prior to shipment. The factory test shall include a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection.
- G. All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.

- H. Performance: All scheduled EER, IEER, capacities and face areas are minimum accepted values. All scheduled amps, kW, and HP are maximum accepted values that allow scheduled capacity to be met.
- I. Warranty: The manufacturer shall provide 12-month parts only warranty. Defective parts shall be repaired or replaced during the warranty period at no charge. The warranty period shall commence at startup or six months after shipment, whichever occurs first.

2.3 CABINET, CASING, AND FRAME

- A. Panel construction shall be double-wall construction for all panels. All floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during service and maintenance. Insulation shall be a minimum of 1" thick with an R-value of 7.0, and shall be 2 part injected foam. Panel design shall include no exposed insulation edges. Unit cabinet shall be designed to operate at total static pressures up to 5.0 inches w.g.
- B. Exterior surfaces shall be constructed of painted galvanized steel, for aesthetics and long-term durability. Paint finish will include a base primer with a high-quality polyester resin topcoat. Finished, unabraded panel surfaces shall be exposed to an ASTM B117 salt spray environment and exhibit no visible red rust at a minimum of 3,000 hours exposure. Finished, abraded surfaces shall be tested per ASTM D1654, having a mean scribe creepage not exceeding 1/16" at 1,000 hours minimum exposure to an ASTM B117 salt spray environment. Measurements of results shall be quantified using ASTM D1654 in conjunction with ASTM D610 and ASTM D714 to evaluate blister and rust ratings.
- C. Service doors shall be provided on the fan section, filter section, control panel section, and heating vestibule in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.
- D. The unit base shall overhang the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base to accept cable or chain hooks for rigging the equipment.

2.4 OUTDOOR/RETURN AIR SECTION

- A. Unit shall be provided with an outdoor air economizer section. The economizer section shall include outdoor, return, and exhaust air dampers. The economizer operation shall be fully integral to the mechanical cooling and allow up to 100% of mechanical cooling if needed to maintain the cooling discharge air temperature. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include moisture eliminator filters to drain water away from the entering air stream. The outside and return air dampers shall be sized to handle 100% of the supply air volume. The dampers shall be parallel blade design. Damper blades shall be gasketed with side seals to provide an air leakage rate of 1.5 cfm / square foot of damper area at 1" differential pressure in according with testing defined in AMCA 500. A barometric exhaust damper shall be provided to exhaust air out of the back of the unit. A bird screen shall be provided to prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges. Control of the dampers shall be by a factory installed direct coupled actuator. Damper actuator shall be of the modulating, spring return type. A comparative enthalpy control shall be provided to sense and compare enthalpy in both the outdoor and return air streams to determine if outdoor air is suitable for "free" cooling. If outdoor air is suitable for "free" cooling, the outdoor air dampers shall modulate in response to the unit's temperature control system.

- B. Economizer assembly Fault Detection and Diagnostics (FDD) shall be 90.1, IECC, and California Title 24 compliant. MicroTech III controls shall display a warning, and write a warning to the BAS, if the economizer malfunctions in accordance with 90.1, IECC, and Title 24 specifications.

2.5 ENERGY RECOVERY

- A. The rooftop unit shall be provided with an AHRI certified rotary wheel air-to-air heat exchanger in a cassette frame complete with seals, drive motor and drive belt. The energy recovery wheel shall be an integral part of the rooftop unit with unitary construction and does not require field assembly. Bolt-on energy recovery units that require field assembly and section to section gasketing and sealing are not acceptable.
- B. The wheel capacity, air pressure drop and effectiveness shall be AHRI certified per AHRI Standard 1060. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Heat Exchangers For Energy Recovery Ventilation Equipment.
- C. The rooftop unit shall be designed with a track so the entire energy recovery wheel cassette can slide out from the rooftop unit to facilitate cleaning.
- D. The unit shall have 2" Merv 7 filters for the outdoor air before the wheel to help keep the wheel clean and reduce maintenance. Filter access shall be by a hinged access door with ¼ turn latches.
- E. The matrix design shall have channels to reduce cross contamination between the outdoor air and the exhaust air. The layers shall be effectively captured in aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belt(s) of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.
- F. The total energy recovery wheel shall be coated with silica gel desiccant permanently bonded without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
- G. Wheels shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning.
- H. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel. Wheels shall be connected to the shaft by means of taper lock hubs.
- I. The exhaust air fan shall be a direct drive SWSI plenum fan. The exhaust fan shall be sized for the airflow requirements per the construction schedule. The unit controller shall control the exhaust fan to maintain building pressure. A VFD shall be provided for the exhaust fan motor or the exhaust fan motor shall be an ECM motor. The rooftop unit shall have single point electrical power connection and shall be ETL listed.

- J. The control of the energy recovery wheel shall be an integral part of the rooftop unit's DDC controller. The DDC controller shall have visibility of the outdoor air temperature, leaving wheel temperature, return air temperature, and exhaust air temperature. These temperatures shall be displayed at the rooftop units DDC controller LCD display. All of these temperatures shall be made available through the BACnet interface.
- K. The rooftop unit with the energy recovery wheel shall incorporate the economizer operation. The energy recovery wheel shall have a bypass damper. When the unit is in the economizer mode of operation the energy recovery wheel shall stop and the bypass dampers shall be opened. The outdoor air shall be drawn through the bypass dampers to reduce the pressure drop of the outdoor airstream.
- L. The rooftop unit DDC controller shall provide frost control for the energy recovery wheel. When a frost condition is encountered the unit controller shall stop the wheel. When in the frost control mode the wheel shall be jogged periodically and not be allowed to stay in the stationary position.

2.6 EXHAUST FAN

- A. Exhaust fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The exhaust fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.
- B. The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
- C. The unit DDC controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25% to 100% of the supply air fan designed airflow to maintain the adjustable building pressure setpoint. The field shall mount the required sensing tubing from the building to the factory mounted building static pressure sensor.

2.7 FILTERS

- A. Unit shall be provided with a draw-through filter section. The filter rack shall be designed to accept a 2" prefilter and a 4" final filter. The unit design shall have a hinged access door for the filter section. The manufacturer shall ship the rooftop unit with 2" MERV 8 and 4" MERV 14 filters.

2.8 COOLING COIL

- A. The indoor coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with a factory piped cooling coil and an ASHRAE 62.1 compliant double sloped drain pan.
- B. The direct expansion (DX) cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design with a minimum of 3 rows. All cooling coils shall have an interlaced coil circuiting that keeps the full coil face active at all load conditions. All coils shall be factory leak tested with high pressure air under water.

- C. The cooling coil shall have an electronic controlled expansion valve. The unit controller shall control the expansion valve to maintain liquid subcooling and the superheat of the refrigerant system.
- D. The refrigerant suction lines shall be fully insulated from the expansion valve to the compressors.
- E. The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Standard 62.1. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil. The drain pan shall have a threaded drain connection extending through the unit base.

2.9 SUPPLY FAN

- A. Supply fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with fan blades that are continuously welded to the hub plate and end rim. The supply fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.
- B. All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment.
- C. Supply fan and motor assembly combinations larger than 8 hp or 22" diameter shall be internally isolated on 1" deflection, spring isolators and include removable shipping tie downs.
- D. The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
- E. The supply fan shall be capable of airflow modulation from 30% to 100% of the scheduled designed airflow. The fan shall not operate in a state of surge at any point within the modulation range.

2.10 HEATING SECTION

- A. The rooftop unit shall include a natural gas heating section, as scheduled. The gas furnace design shall be one natural gas fired heating module factory installed downstream of the supply air fan in the heat section. The heating module shall be a tubular design with in-shot gas burners.
- B. The module shall be complete with furnace controller and control valve capable of 5:1 modulating operation.
- C. The heat exchanger tubes shall be constructed of stainless steel.
- D. The module shall have an induced draft fan that will maintain a negative pressure in the heat exchanger tubes for the removal of the flue gases.
- E. Each burner module shall have two flame roll-out safety protection switches and a high temperature limit switch that will shut the gas valve off upon detection of improper burner manifold operation. The induced draft fan shall have an airflow safety switch that will prevent the heating module from turning on in the event of no airflow in the flue chamber.

- F. The factory-installed DDC unit control system shall control the gas heat module. Field installed heating modules shall require a field ETL certification. The manufacturer's rooftop unit ETL certification shall cover the complete unit including the gas heating modules

2.11 CONDENSING SECTION

- A. Outdoor coils shall be cast aluminum, micro-channel coils. Plate fins shall be protected and brazed between adjoining flat tubes such that they shall not extend outside the tubes. A sub-cooling coil shall be an integral part of the main outdoor air coil. Each outdoor air coil shall be factory leak tested with high-pressure air under water.
- B. Fan motors shall be an ECM type motor for proportional control. The unit controller shall proportionally control the speed of the condenser fan motors to maintain the head pressure of the refrigerant circuit from ambient condition of 25~120°F. Mechanical cooling shall be provided to 25° F. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.
- C. The condenser fan shall be low noise blade design. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be of a composite materia
- D. The unit shall have scroll compressors. One of the compressors shall be an inverter compressor providing proportional control. The unit controller shall control the speed of the compressor to maintain the discharge air temperature. The inverter compressor shall have a separate oil pump and an oil separator for each compressor that routes oil back to the compressor instead of through the discharge line.
- E. Pressure transducers shall be provided for the suction pressure and head pressure. Temperature sensor shall be provided for the suction temperature and the refrigerant discharge temperature of the compressors. All of the above devices shall be an input to the unit controller and the values be displayed at the unit controller.
- F. Refrigerant circuit shall have a bypass valve between the suction and discharge refrigerant lines for low head pressure compressor starting and increased compressor reliability. When there is a call for mechanical cooling the bypass valve shall open to equalizing the suction and discharge pressures. When pressures are equalized the bypass valve shall close and the compressor shall be allowed to start.
- G. Each circuit shall be dehydrated and factory charged with R-410A Refrigerant and oil.

2.12 ELECTRICAL

- A. Unit wiring shall comply with NEC requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with the unit shall be number and color-coded and labeled according to the electrical diagram provided for easy identification. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 115-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit. Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Supply fan motors shall have

contactors and external overload protection. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance.

- B. A single non-fused disconnect switch shall be provided for disconnecting electrical power at the unit. Disconnect switches shall be mounted internally to the control panel and operated by an externally mounted handle.

2.13 CONTROLS

- A. Units shall be provided with Factory installed refrigeration only controls.
- B. Provide a terminal strip for fans, energy wheel, dampers, etc., that are not part of the refrigeration control system, to allow field fabricated controls by the controls contractor.

2.14 ROOF CURB

- A. A prefabricated heavy gauge galvanized steel, mounting curb shall be provided for field assembly on the roof decking prior to unit shipment. The roof curb shall be a full perimeter type with complete perimeter support of the air handling section and condensing section. The curb shall be a minimum of 14" high and include a nominal 2" x 4" wood nailing strip. Gasket shall be provided for field mounting between the unit base and roof curb.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. Verify roof curbs are installed and dimensions are as instructed by manufacturer.

3.2 INSTALLATION

- A. Roof Curb:
 - 1. Assemble roof curb.
 - 2. Install roof curb level.
 - 3. Coordinate curb installation and flashing with all sections of specifications.
 - 4. Install units on roof curb providing watertight enclosure to protect ductwork and utility services.
 - 5. Install gasket material between unit base and roof curb.
- B. Connect units to supply and return ductwork with flexible connections. Refer to Section 233300.
- C. Install condensate piping with trap and route from drain pan to nearest roof drain.
- D. Install components furnished loose for field mounting.
- E. Install electrical devices furnished loose for field mounting.

- F. Install control wiring between unit and field installed accessories.
- G. Remove from roof and dispose off-site panels removed from units during installation of economizer and dampers.
- H. Locate remote panels as required by controls contractor.

3.3 INSTALLATION - HOT WATER HEATING COIL

- A. Make connections to coils with unions or flanges.
- B. Connect water supply to leaving airside of coil (counter flow arrangement).
- C. Locate water supply at bottom of supply header and return water connection at top.
- D. Install water coils to allow draining and install drain connection at low points.
- E. Install valves and piping specialties in accordance with details as indicated on Drawings.
- F. Install manual air vents at high points complete with shutoff valve. Refer to Section 232113.
- G. Install hot water piping accessories within unit casing.

3.4 MANUFACTURER'S FIELD SERVICES

- A. Section 014000 - Quality Requirements: Requirements for manufacturer's field services.
- B. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.

3.5 CLEANING

- A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Vacuum clean coils and inside of cabinets.
- C. Install new throwaway filters in units at Substantial Completion.

3.6 DEMONSTRATION

- A. Section 017000 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate unit operation and maintenance.
- C. Furnish services of manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.

3.7 SCHEDULES

- A. Rooftop Units Schedule:
 - 1) Refer to schedule on Plans.

END OF SECTION 237416

SECTION 23 81 26

SPLIT-SYSTEM AIR-CONDITIONERS

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. Indoor Split System
- B. Related Sections:
 - 1. Division 20 – All Sections
 - 2. Section 23 09 23 - Control Devices
 - 3. Section 23 09 93 - Sequence of Operations.
 - 4. Section 23 23 00 - Refrigerant Piping: Execution requirements for connection to refrigerant piping specified by this section.
 - 5. Section 26 05 03 - Equipment Wiring Connections

1.3 REFERENCES

- A. Air-Conditioning and Refrigeration Institute:
 - 1. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
 - 2. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
 - 3. ARI 340/360 - Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.
 - 4. ARI 365 - Commercial and Industrial Unitary Air-Conditioning Condensing Units.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
 - 2. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. ASTM International:
 - 1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
- D. National Electrical Manufacturers Association:
 - 1. NEMA MG 1 - Motors and Generators.
- E. National Fire Protection Association:
 - 1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit data indicating:

1. Cooling and heating capacities.
2. Dimensions.
3. Weights.
4. Rough-in connections and connection requirements.
5. Duct connections.
6. Electrical requirements with electrical characteristics and connection requirements.
7. Controls.
8. Accessories.

C. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

D. Manufacturer's Field Reports: Submit start-up report.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of controls installed remotely from units.
- C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.6 QUALITY ASSURANCE

- A. Performance Requirements: Energy Efficiency Rating (EER) not less than prescribed by ASHRAE Standard for the Design of High Performance Green Buildings when used in combination with compressors and evaporator coils when tested in accordance with ARI 210/240.
- B. Cooling Capacity: Rate in accordance with ARI. Sound Rating: Measure in accordance with ARI 270.
- C. Insulation and adhesives: Meet requirements of NFPA 90A.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.
- C. Comply with manufacturer's installation instruction for rigging, unloading and transporting units.
- D. Protect units from weather and construction traffic by storing in dry, roofed location.

1.8 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Coordinate installation of condensing units with roof structure.

1.9 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.
- B. Manufacturer shall provide a limited "parts only" warranty for a period of 12 months from the date of equipment startup or 18 months from the date of original equipment shipment from the factory, whichever is less. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer's written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance and refrigerant.
- C. Furnish five year manufacturer's warranty for compressors.

1.10 MAINTENANCE SERVICE

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance service.
- B. Furnish service and maintenance of equipment for one year from Date of Substantial Completion. Include maintenance items as shown in manufacturer's operating and maintenance data, including filter replacements, fan belt replacement, and controls checkout and adjustments.
- C. Furnish 24-hour emergency service on breakdowns and malfunctions for this maintenance period. Furnish capability of response time within 2 hours.

1.11 MAINTENANCE MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

1.12 PERFORMANCE

- A. The system performance shall be in accordance with AHRI 210/240 test conditions for the equipment specified and scheduled. The cooling performance is based on 80°F DB / 67°F WB for the indoor unit and 95°F DB / 75°F WB for the outdoor unit and 25 feet of piping. The heating performance is based on 70°F DB / 60°F WB for the indoor unit and 47°F DB / 43°F WB for the outdoor unit and 25 feet of piping.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Daikin (Basis of Design)
 - a. Indoor Unit: FTXS36LVJU
 - b. Outdoor Unit: RKS36LVJU
 - 2. Mitsubishi
 - 3. LG
 - 4. Or equal as approved by the Professional.

2.2 INDOOR UNIT

A. General:

1. The indoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. Both liquid and suction lines must be individually insulated between the outdoor and indoor units.

B. Unit Cabinet:

1. The indoor unit shall be constructed of heavy gauge galvanized steel.
2. The unit shall be internally insulated and shall be capable of installation in indoor environments up to 80% relative humidity without requiring additional field installed insulation.
3. The drain and refrigerant piping shall be accessible from the right side.
4. The cabinet shall have a factory rear return air position with the ability to convert to bottom return.
5. The cabinet shall include a drain pan inspection port on the right side to observe drain pan conditions.

C. Fan:

1. The evaporator fan shall be an assembly consisting of a direct-driven fan by a single motor.
2. The fan shall be statically and dynamically balanced and operate on a motor with permanent lubricated bearings.
3. The indoor fan shall offer a choice of three speeds, plus quiet setting.
4. The fan shall have a delayed start when initially put into HEAT operation, giving time for the evaporator coil to heat up and preventing a cold draft from entering the room.
5. The unit shall be equipped with internal controls to allow the fan motor to be manually adjusted, via field setting, to deliver airflow at a variety of external static pressures.

D. Coil:

1. The evaporator coil shall be a nonferrous, aluminum fin on copper tube heat exchanger.
2. All tube joints shall be brazed with silver alloy or phoscopper.
3. All coils will be factory pressure tested.
4. A condensate pan shall be provided under the coil with a drain connection.
 - a. The unit shall be equipped with a factory-integral condensate lift mechanism capable of 26-9/16 inches of lift.

E. Electrical:

1. The outdoor unit shall be powered with 208-230 volts, 1 phase, and 60 hertz power. The indoor unit shall receive 208-230 volt, 1 phase, 60 hertz power from the outdoor unit.
2. The allowable voltage range shall be 187 volts to 253 volts.

F. Control:

1. The unit shall be stand-alone with no BAS monitoring.
2. The unit shall have either a Wired type remote controller.
3. The controller shall be able to display two-digit fault codes extracted from the indoor unit to aid in troubleshooting.
4. The indoor unit microprocessor has the capability to receive and process commands via return air temperature and indoor coil temperature sensors enabled by commands from the remote control.

G. Sound:

1. Indoor unit sound levels are as scheduled.
 - a. *values are measured approximately 5 feet away with fan speed on high, approximately 6.6 ft of supply duct, and 3.3 ft of return duct.

2.3 OUTDOOR UNIT

General:

The outdoor unit shall be specifically matched to the corresponding indoor unit size. The outdoor unit shall be complete factory assembled and pre-wired with all necessary electronic and refrigerant controls. The outdoor shall be controlled by a microprocessor and dedicated EEV's shall be provided for capacity control during part load of the indoor unit.

A. Manufacturers: Matching Indoor Unit

B. Unit Cabinet:

1. The outdoor unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.
2. The outdoor unit will come furnished with four (4) mounting feet, mounted across the base pan, to allow bolting to a wall mounting bracket.

C. Fan:

1. The fan shall be a direct drive, propeller type fan.
2. The motor shall be inverter driven, permanently lubricated type bearings, inherent.
3. A fan guard is provided on the outdoor unit to prevent contact with fan operation.
4. Airflow shall be horizontal discharge.

D. Coil:

1. The outdoor coil shall be nonferrous construction with corrugated fin tube.
2. The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film type E1, rated for up to 1000 hours salt spray.
3. Refrigerant flow from the condenser will be controlled via a metering device.
4. Automatic defrost will remove any frost from the outdoor unit allowing the system to maintain heating capacity.

E. Compressor:

1. The outdoor compressor shall be a patented, variable speed Daikin swing inverter-driven compressor. The one piece action reduces noise, extends life, boasts higher efficiency and reduces energy consumption.
2. The outdoor unit shall have an accumulator and four-way reversing valve.
3. PVE Refrigerant Oil shall be used to provide improved lubrication & better chemical stability, and no hydrolysis, leading to higher product reliability.
4. The compressor shall have an internal thermal overload.
5. The outdoor unit can operate with a maximum vertical height difference of 65-5/8 feet and overall maximum length of 98-1/2 feet without any oil traps or additional components.
6. The compressor shall have a quick-warming function to prevent pumping liquid refrigerant in low-ambient conditions.

F. Electrical:

1. The electrical power requirement is 208-230 volt, 1-phase, and 60 Hz power.
2. The voltage range limitations shall be a minimum of 187 volts and a maximum of 253 volts.

G. Sound:

1. Outdoor unit sound levels shall not exceed that scheduled.
 - a. *values are based on high fan speed and are measured approximately 3 feet away.

2.4 SYSTEM DIAGNOSTICS

General:

The system shall be capable of producing 2-digit fault codes:

- A. Controls
 - 1. Wired controller
- B. D-Checker software: The D-Checker software has the ability to display error codes and values for every sensor on the system through the outdoor unit. The sensor data points shall be graphed or recorded for export to a spreadsheet. The spreadsheet can then be analyzed to troubleshoot operational issues or acknowledge proper operation.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify concrete pad for condensing unit is ready for unit installation.

3.2 INSTALLATION – AIR HANDLING UNITS

- A. Installation, Operation and Maintenance manual shall be supplied with the unit.
- B. Installing contractor shall install unit, including field installed components, in accordance with Installation, Operation and Maintenance manual instructions.
- C. Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit.
- D. Install components furnished loose for field mounting.

3.3 INSTALLATION - CONDENSING UNIT

- A. Installation, Operation and Maintenance manual shall be supplied with the unit.
- B. Installing contractor shall install unit, including field installed components, in accordance with Installation, Operation and Maintenance manual instructions.
- C. Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit.
- D. Install refrigerant piping from unit to condensing unit. Install refrigerant specialties furnished with unit.
- E. Evacuate refrigerant piping and install initial charge of refrigerant.
- F. Install electrical devices furnished loose for field mounting.

G. Install control wiring between terminal unit, condensing unit, thermostat and field installed accessories.

H. Install connection to electrical power wiring.

3.4 MANUFACTURER'S FIELD SERVICES

A. Section 01 40 00 - Quality Requirements: Requirements for manufacturer's field services.

B. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.

3.5 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

B. Vacuum clean coils and inside of unit cabinet.

C. Install temporary filters during construction period. Replace with permanent filters at Substantial Completion.

3.6 DEMONSTRATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate terminal unit operation and maintenance.

C. Demonstrate starting, maintenance, and operation of condensing unit including low ambient temperature operation.

D. Furnish services of manufacturer's technical representative for two hours to instruct Owner's personnel in operation and maintenance of units.

3.7 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Do not operate terminal units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION 238126

SECTION 23 82 00

CONVECTION HEATING UNITS

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. Unit Heaters.
 - 2. Air Curtains.
- B. Related Sections:
 - 1. Section 230513 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
 - 2. Section 230700 - HVAC Insulation: Execution requirements for insulation specified by this section.
 - 3. Section 232113 - Hydronic Piping: Execution requirements for connection of chilled water, hot water, and drain piping to units specified by this section.
 - 4. Section 232116 - Hydronic Piping Specialties: Product requirements for hydronic piping specialties for placement by this section.
 - 5. Section 232213 - Steam and Condensate Heating Piping: Execution requirements for connection of steam supply and steam condensate return piping to units specified by this section.
 - 6. Section 232216 - Steam and Condensate Piping Specialties: Product requirements for steam piping specialties for placement by this section.
 - 7. Section 232300 - Refrigerant Piping: Execution requirements for connection of refrigerant piping to units specified by this section.
 - 8. Section 233100 - HVAC Ducts and Casings: Execution requirements for ducts specified by this section.
 - 9. Section 260503 - Equipment Wiring Connections: Execution requirements for electric connection to units specified by this section.

1.3 REFERENCES

- A. Air-Conditioning and Refrigeration Institute:
 - 1. ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
- B. Sheet Metal and Air Conditioning Contractors:
 - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.4 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations. Indicate schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers.
- C. Product Data: Submit coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions. Submit mechanical and electrical service locations, capacities and accessories or optional items.
- D. Samples: Submit one sample of each radiation cabinet detailed.
- E. Manufacturer's Installation Instructions: Submit assembly, support details, and connection requirements.
- F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access to valves.
- C. Operation and Maintenance Data: Submit manufacturers descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with Pennsylvania DGS standards.
- B. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years' documented experience approved by manufacturer.

1.8 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Product storage and handling requirements.
- B. Accept units on site in factory packing. Inspect for damage. Store under roof.
- C. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors. Protect coils from entry of dirt and debris with pipe caps or plugs.

1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.11 WARRANTY

- A. Section 017000 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish two-year manufacturer's warranty.

1.12 EXTRA MATERIALS

- A. Section 017000 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two sets of filters.

PART 2 - PRODUCTS

2.1 UNIT HEATERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. MODINE (Basis of Design)
 - 2. Reznor
 - 3. Dayton
 - 4. Or equal as approved by the Professional
- B. GENERAL
 - 1. Contractor shall furnish and install steam/hot water unit heaters as scheduled. Performance shall be as indicated on the equipment schedule in the plans. Units shall be listed by UL Std. No. 1995 "Heating and Cooling Equipment."
- C. CASING
 - 1. HSB and HC Models - Casings on model sizes 18 through 86 are 20 gauge steel (18 gauge on all other models) and consist of front and back halves. Both halves are joined together at the top and bottom utilizing the condenser mounting screws. Casing top is provided with threaded hanger connections for unit suspension (except for HSB 18 and HSB 24 which are directly mounted to the supply and return piping). Fan venturi is formed in casing back half.

2. Vertical and Power-Throw™ Models - Casings consist of two circular 18 gauge steel covers. With the coil in between, the covers are securely bolted together to form a single unit. The bottom cover has a die-formed fan venturi. The top cover incorporates a motor cooling cone, which shields the motor from coil heat therefore prolonging motor life. An opening is also provided for circulation of motor cooling air.
3. All Models - Casing shall be treated to prevent corrosion and painted with a corrosion resistant, baked, polyester powdercoat gray-greenfinish.

D. CONDENSER

1. Condenser coils are of the extended surface type, utilizing aluminum fins and DLP-type copper tubes with malleable iron supply and return connections for HSB units, cast bronze connections for HC models and Schedule 40 steel pipe for V/PT models. Tubes are mechanically bonded to the collars of the fins. The condensers are warranted for operation at steam or hot water pressures and temperatures up to 150 psig and 375°F for copper coils and 250 psig and 400°F for 90/10 cupro-nickel coils.
2. Fins are continuous across the width and depth of the condenser and are vertically oriented to minimize the collection of dirt and dust.
3. All coils are leak tested at 165 to 200 psig, air under water.
4. Horizontal Models - Coils are of serpentine design with horizontal tubes, vertical fins and center supply and return connections at top and bottom of unit (except HC models, which have side connections). All tube bends are brazed. All tubes have individual expansion bends. Copper tubes are 1" O.D. with 0.030" wall thickness (except HSB/HC 18 and 24 which are 5/8" O.D. with 0.028" wall thickness).
5. Vertical and Power-Throw™ Models - Coils are circular, providing for natural expansion. Each tube is continuous between supply and return header. All tube joints are silver soldered. Copper tubes are 5/8" O.D. with 0.028" wall thickness.

E. Motors

1. Power requirements shall be as scheduled and shown on electrical plans. Motors are designed for continuous duty and can operate in a maximum ambient temperature of 104°F(40°C).

F. Fans/Fan Guards

1. Fans are aluminum on all units and are secured to a steel hub. Each fan is balanced and is designed specifically for the unit heater on which it is installed. Horizontal units are equipped with a combination fan guard/motor-mounting bracket. The guard is constructed of steel rod. Vertical units are supplied with an outlet fan guard covering the opening in the bottom of the unit.

G. Air Deflectors

1. Horizontal units, including the Power-Throw™ units, are furnished with horizontal air deflectors as standard. The deflectors are adjustable to almost any desired position for downward, straight or upward airflow. Vertical deflectors are available as an accessory for HSB/HC models through size 193, standard on model sizes 258-340. See page 22 for air outlet accessories for vertical models.

H. Schedule:

1. UH-1: HC-18
2. UH-2: HC-18
3. UH-4: V-139

2.2 AIR CURTAINS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
1. Powered Aire Inc. (Basis of Design)
 2. Mars Air Systems, LLC
 3. Schwank
 4. Or equal as approved by the Professional
- B. EQUIPMENT BASIC DESCRIPTION – BASIS-OF-DESIGN
1. Each unit consists of a factory assembled casing, centrifugal fans, slotted grill, discharge nozzle, motor(s), and access panels for motor and fan assembly. Additional accessories as specified. The air curtain provides a specific CFM and a uniform outlet velocity across the entire length of the discharge nozzle area. A remote or unit mounted Nema 12 control panel will be provided.
- C. CASING:
1. Housing Materials: Bottom intake slotted grill shall be painted steel. Other casing shall be galvanized steel.
 2. Unit Support: Integral to the unit frame or casing. All weight bearing structural support shall be formed galvanized steel. Units shall be furnished in single increments of sufficient structural strength to be supported from the top per manufacturer's instructions.
- D. AIR DISCHARGE NOZZLE
1. A. Discharge nozzle shall be high efficiency discharge plenum. Air curtain creates a positive air seal with directional air foil vane. The vane shall facilitate a deflection of the air stream by +/- 20 degrees.
- E. FANS
1. Wheels: Galvanized forward curved centrifugal type, double inlet design, with zinc plated hubs.
 2. Drives: Direct Drive. Belt Drive Not Acceptable.
- F. MOTORS:
1. Type: Open Drip Proof (ODP), multi-speed, resiliently mounted, continuous duty, air over with integral thermal-overload protection.
 2. Bearings: Heavy duty type permanently lubricated, shielded ball bearings of equal size.
- G. HOT WATER HEAT
1. Description: Factory mounted hot water coil. The coil shall be mounted to the intake of air curtain.
 2. Hot Water Supply and Return Piping Connections: Threaded
 3. Tubes: Copper, complying with ASTM B 75.
 4. Tube Diameter: 0.625 inch. O.D.
 5. Fin and Tube Joint: Mechanical bond
 6. Headers: Seamless copper tube with brazed joints.
 7. Ratings: According to ARI standard 410.
 8. Source Quality Control: Coils shall be tested at 550 psig using dry nitrogen, submerged under water. Dual-operator verification shall determine that all coils are leak-free.

9. Coil Connections: Contractor shall confirm handedness according to field and installation conditions.
10. Valves and Valve Controls by contractor.

H. FILTERS

1. A. Filter Type: ½" thick cleanable

I. ACCESSORIES

1. Disconnect: remote mounted, non-fused
2. Automatic Door Switch: Remotely installed in the door area to activate the unit each time the door opens and deactivate the unit each time the door closes.
3. Adjustable Time Delay: Integral part of the panel, only used with an automatic door switch. Air curtain to operate until specified time (adjustable from 1.0 to 100 seconds) after the door closes.
4. Thermostat: Hot Water: Turns air curtain fans on and off according to temperature, to operate the unit as a space heater. low voltage, remote mounted, panel mounted.

J. SCHEDULE

1. UH-3: CLD-2-72HW

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Coordination and project conditions.
- B. For recessed units, verify recess dimensions are correct size.
- C. Verify wall construction is ready for installation.
- D. Verify ductwork is ready for installation.
- E. Verify concealed blocking and supports are in place and connections are correctly located.

3.2 INSTALLATION

- A. Install air coils in ducts and casings in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible. Refer to Section 233100.
- B. Support air coil sections independent of piping on steel channel or double angle frames and secure to casings. Furnish frames for maximum three coil sections. Arrange supports to avoid piercing drain pans. Install with airtight seal between coil and duct or casing.
- C. Protect coils to prevent damage to fins and flanges. Comb out bent fins.
- D. Install coils level.
- E. Make connections to coils with unions and flanges.

- F. On water coils, install shut-off valve on supply piping and lockshield balancing valve on return piping. Locate water supply at bottom of supply header and return water connection at top. Install manual air vents at high points complete with stop valve. Install water coils to be drainable and install drain connection at low points. Refer to Section 232113.
- G. On water and glycol heating coils, and chilled water cooling coils, connect water supply piping to leaving airside of coil (counter flow arrangement). Refer to Section 232113.
- H. Install insulation air coil casings. Refer to Section 230700.
- I. Insulate headers located outside airflow, insulate as specified for piping. Refer to Section 230700.
- J. Install equipment exposed to finished areas after walls and ceilings are finished and painted. Avoid damage.
- K. Protection: Install finished cabinet units with protective covers during remainder of construction.
- L. Unit Heaters: Hang from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated.
- M. Air Curtains: Hang units from building structure, coordinate location with doors and ceiling grid. Install each air curtain in accordance with the Installation Instructions provided by the manufacturer of the air curtain.
- N. Hydronic Units: Install with shut-off valve on supply piping and lockshield balancing valve on return piping. Where not accessible, extend vent to exterior surface of cabinet for servicing. For cabinet unit heaters, fan coil units, and unit heaters, install float operated automatic air vents with stop valve. Refer to Section 232113.
- O. Install electric heating equipment including devices furnished by manufacturer but not factory-mounted. Furnish copy of manufacturer's wiring diagram submittal. Install electrical wiring in accordance with manufacturer's submittals and Section 260503.

3.3 SYSTEM STARTUP

- A. Startup each piece of equipment per manufacturers operations and maintenance manual and installation instructions.

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing air curtains completely, perform visual and mechanical check of individual components.
 - 2. After electrical circuitry has been energized, start unit to confirm motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Repair or replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

- A. Adjust air-directional vanes.

3.6 CLEANING

- A. Section 017000 - Execution and Closeout Requirements: Final cleaning.
- B. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- C. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.
- D. Install new filters.

3.7 DEMONSTRATION

- A. Contractor to instruct the Owners' maintenance personnel on how to adjust, operate and maintain each piece of equipment.

3.8 SCHEDULES

- A. Refer to Plans.

END OF SECTION 238200

SECTION 260500
BASIC ELECTRICAL REQUIREMENTS

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. Applicable requirements of the Drawings, Owner/ Contractor Agreement, General Conditions, Supplementary Conditions, Division 1 - General Requirements, and Unified Facilities Criteria Standards are part of this Section and have the same force and effect as if printed herein in full.

1.3 DESCRIPTION

- A. The work to be performed consists of the satisfactory completion of Electrical and Auxiliary products as follows:
 - 1. Demolition of existing systems.
 - 2. Temporary power, communication, fire alarm, security and lighting systems.
 - 3. Normal power distribution system.
 - 4. Grounding.
 - 5. Electrical requirements for heating, ventilation and plumbing equipment.
 - 6. Electrical requirements for miscellaneous equipment.
 - 7. General purpose and specialty receptacles.
 - 8. Interior Lighting and controls.
 - 9. Fire Alarm System.
 - 10. Security system.
 - 11. Exterior lighting
 - 12. Telephone/data system.
 - 13. Intercom system.
 - 14. Coordination with work of other Contractors.
- B. The Contractor shall provide all labor, material, equipment and services for the complete and proper installation and operation of the electrical work as indicated, required or implied by the drawings and as specified herein. This includes work for other Divisions required to complete all the work ready for operation.
- C. All of the specifications listed and all of the drawings listed are part of the Contract Documents of each of the Prime Contractors. Each Prime Contractor shall review all drawings and specification divisions to determine the full scope of their work.

1.4 DEFINITIONS

- A. When applied to equipment and materials, the words “furnish”, “install”, and “provide” shall mean the following
 - 1. The word “provide” shall mean to furnish, pay for, deliver, assemble, install, adjust, clean and otherwise make materials and equipment fit for their intended use.
 - 2. The work “furnish” shall mean secure, pay for, deliver to site, unload and uncrate equipment and materials.
 - 3. The word “install” shall mean to assemble, place in position, incorporate in the work, adjust, clean and make fit for use.
 - 4. The phrase “furnish and install” shall be equivalent to the word “provide.”

1.5 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code
- B. NECA - National Electrical Contractors' Association
- C. NEMA - National Electrical Manufacturers' Association
- D. IBC – International Building Code.
- E. UL - Underwriters' Laboratories, Inc.
- F. FS - Federal Specifications.
- G. NESC - National Electrical Safety Code.
- H. ANSI - American National Standards Institute.
- I. IESNA - Illuminating Engineering Society of North America.
- J. IEEE - The Institute of Electrical and Electronic Engineers.
- K. The Insulated Cable Engineers Association
- L. National Bureau of Standards.
- M. National Fire Protection Association.
- N. Occupational Safety and Health Administration.
- O. U.S. Environmental Protection Agency.
- P. International Electrical Testing Association.
- Q. Other standards as referenced in individual sections.

1.5 RELATED SECTIONS

- A. Section 015000 – Temporary Facilities.

1.6 LAWS, REGULATORY REQUIREMENTS, AND PERMIT

- A. Comply with applicable laws and regulations in accordance with the General Conditions, Supplementary Conditions and the applicable Section of DIVISION 1 General Provisions Special Conditions and General Requirements.
- B. Conform to applicable Local Building Code.
- C. Electrical: Conform to latest NFPA 70 adopted by local jurisdiction.
- D. During construction, the Contractor shall be responsible for providing all his employees with working conditions as prescribed in the "Safety and Health Regulations for construction" of the Occupational Safety and Health Administration of the U.S. Department of Labor.
- E. Obtain permits, and request inspections from authority having jurisdiction. Contractor shall pay permit, inspection, and certification fees.
- F. The Engineer and Owner shall not be held liable for any bodily injury or property damage resulting from the Contractor's operation.
- G. Listing and Labeling: All equipment specified herein and in other Division 26 specification sections, for which label service is available, shall be listed and labeled for their applications and installation conditions and for the environments in which installed.
 - 1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.
 - 2. Listed and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7. The agencies shall also be acceptable to the local authority having jurisdiction.

1.7 SITE VISIT

- A. The Contractor is required to visit the site during the bidding period and thoroughly familiarize himself with the conditions, points of connection to existing systems, scope, and quantities of work involved. In addition, the contractor shall determine means required to provide accessibility for equipment and materials in their final locations.
- B. Bidders shall notify the Engineer, prior to bidding, of any discrepancies between existing site conditions and requirements of contract documents. The Engineer will issue clarification prior to submission of bids. Lack of this notification to Engineer will result in binding interpretation by the Engineer.
- C. Submission of bid shall be interpreted as having complied with the above conditions of the site visit.

1.8 PROJECT/SITE CONDITIONS

- A. Install equipment and material having capacities not less than those required by the design criteria.
- B. Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to Work specified in other Sections. Obtain permission of Engineer before proceeding.
- C. Install bracing, shoring, rails, guards and covers necessary to prevent damage or injury.

1.9 FINAL CONNECTIONS

- A. Final electrical connections to equipment installed by the General, Plumbing, Mechanical Contractors and others shall be made by the Electrical Contractor. Coordinate size, location and requirements of equipment prior to connection of electrical work.

1.10 INTENT OF DRAWINGS AND SPECIFICATIONS

- A. The implied and stated intent of the drawings and specifications is to establish minimum acceptable quality standards for materials, equipment and workmanship and to provide operable electrical systems complete in every respect. The drawings and specifications are meant to be complimentary to each other. Should there be a conflict, the most expensive method shall be used in preparation of bid. Conflict shall be resolved by Architect/Engineer after award of contract, if not before.
- B. The drawings are diagrammatic, intending to show general arrangements and location of system components, and are not intended to be rigid in detail.
- C. Due to the small scale of the drawings, and to unforeseen job conditions, all required offsets and fittings are not shown but shall be provided at no change in Contract price.
- D. The layout of wiring on the small scale drawings shall not be considered absolute. The design shall be subject to such revisions as may be necessary to overcome obstructions. No changes shall be made in item locations, the method of wiring, or the placing of apparatus without written consent of the Engineer.

1.11 MATERIALS

- A. All materials used in the work shall be new, free of defects, the best of their respective kinds, and shall be installed by labor thoroughly skilled in the class of work anticipated by this Contract.

1.12 RECORD DRAWINGS

- A. Record drawings shall be kept in accordance with Division 1 requirements and as indicated below.
- B. Maintain on site, one set of the following record documents:
 - 1. Contract Drawings.
 - 2. Specifications.
 - 3. Addenda.
 - 4. Change Orders and other modifications to the contract.
 - 5. Reviewed shop drawings, product data, and samples.
- C. Record actual revisions to the work.
- D. Store record documents separate from documents used for construction.
- E. Record information concurrent with construction progress.
- F. Provide digital pictures of duct bank crossings with other piping systems and at building entrances, prior to backfilling excavations.
- G. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:

1. Manufacturer's name and product model and number.
 2. Product substitutions or alternates utilized.
 3. Changes made by addenda and modifications.
- H. Record drawings and shop drawings: Legibly mark each item to record actual construction including:
1. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 2. Measured locations of internal utilities to include equipment, conduit, access doors, controls, fixtures, and all other accessories as required.
 3. Field changes of dimension and detail.
 4. Details not on original contract drawings.
- I. Delete engineer title block and seal from all documents.
- J. Submit documents to engineer with claim for final application for payment.

1.13 TRANSPORTATION AND HANDLING

- A. Transport and handle products in accordance with manufacturer's instructions.
- B. Promptly inspect shipments to assure that products comply with requirements, and products are undamaged.
- C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.14 STORAGE AND PROTECTION

- A. Store and protect products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight, climate controlled enclosures.
- B. All electrical construction materials such as building wire, outlet and junction boxes, wiring devices, panelboards, conduit, lighting fixtures, etc. shall be stored in construction buildings, covered trailers or portable covered warehouses. Any equipment subject to damage or corrosion from excessive moisture shall be stored in dry, heated areas. Any equipment containing plastic or material subject to damage caused by excessive heat or sunlight shall be stored in building, covered trailers or portable covered warehouse, to prevent such damage. This includes any plastic materials like lenses and conduits.
- C. Larger diameter cables may be stored on reels outside; however, all cable ends shall be waterproofed and the ends covered with waterproofed materials. Such weatherproof materials shall be heavy duty, securely fastened and made impervious to the elements.
- D. All electrical work shall also be protected against damage caused by carelessness of workmen of other Trades who are installing equipment connected to or adjacent to the electrical equipment.
- E. Equipment, damaged as a result of conditions described in the preceding paragraphs, shall be repaired at the Contractor's expense. Equipment shall be replaced at the Contractor's expense, if equipment has been damaged to such an extent that it can not operate properly after repairs are made. The Owner shall determine if repair and/or replacement is required.

- F. All electrical equipment exposed to construction damages such as paint spots, speckling or plaster splatter, grout splashes, waterproofing compound, tar spots or runs and pipe covering compound splashes, shall be completely covered beforehand to protect against such damage.
- G. In the event leakage of any foreign material or fluid occurs or may occur in the manholes of duct banks, the Contractor shall take all steps as described above to protect all equipment.
- H. After connections to electrical equipment are completed and the equipment is ready for operation, all construction debris shall be removed from all enclosures. Such debris includes dust, dirt, wire clippings, tape and insulation removed and all miscellaneous construction debris.
- I. Provide off-site storage and protection when site does not permit on-site storage or protection.

1.15 WORK SEQUENCE

- A. Install work in phases to accommodate Owner's present occupancy requirements during the construction period. Coordinate electrical schedule and operations with Owner, General Contractor and other portions of the specifications. Building 237 provides power to Building 238. The transformer powering Building 237 also powers Buildings 232, 242, 243 and 307. All shutdowns shall be coordinated with owner.
- B. The cost of any anticipated overtime work shall be included in the Contractor's base bid. Requests for additional compensation for this work after award of contract will be refused.

1.16 COORDINATION OF WORK

- A. Prior to submitting bids, and also during construction, the Contractor shall examine all drawings in the bid package. The work of all Contractors shall be carefully considered, and the work of the Contractor and each of the Sub-contractors shall be carefully planned, scheduled, and coordinated with all other Contractors so that all parts of their work will be compatible with, and not interfere with Other Trades.
- B. The contractor shall submit a dimensioned layout of the electrical rooms with the shop drawings indicating code required clearances and equipment removal access. Equipment shop drawings will not be reviewed without the room layout.
- C. Review with the Architect/Engineer and all other Contractors, locations of all equipment and materials so that all work may be installed in the most direct manner and interferences are avoided between pipes, ducts, conduits, equipment and architectural and structural features. Coordinate space requirements and installation of mechanical and electrical work which are indicated diagrammatically on drawings. Utilize space efficiently to maximize accessibility for other installations, for maintenance and for repairs. If interference develops, meet with the Architect/Engineer and all other Contractors affected, coordinate work and correct interferences. Where interferences occur during construction because of failure to coordinate work, each trade shall rearrange work, at no additional cost to the Owner. Engineer will determine which work shall be relocated - regardless of which was installed first.
- D. Contractor shall distribute to the Other Trades as required, all setting plans, templates, approved shop drawings, approved electrical wiring diagrams, etc. to insure proper space and functional relationship to other equipment and services.

- E. In crowded locations such as corridors, where composite cross sections of piping and conduit are not indicated, the Contractor shall submit shop drawings which will include composite cross sections of all the various trades in order to avoid interference during construction.
- F. Coordinate the procurement of specified materials and equipment being supplied by Sub-contractors, manufacturers and vendors. This includes verifying utility requirement characteristics of operating equipment are compatible with building utilities
- G. Contractor shall provide a start-up/energization plan for the new electrical systems.

1.17 CLEANING

- A. After construction is completed, including painting, clean exposed surfaces of equipment. Vacuum clean inside of cabinets.
- B. Touch-up marred or scratched surfaces of factory- finished equipment, using finish materials furnished by equipment manufacturer.

1.18 HOUSEKEEPING PADS

- A. Provide housekeeping pads under provisions of Section 033000, Cast-In-Place Concrete as required. Minimum height shall be 6 inches above finished floor for exterior and 4 inches for interior unless designed otherwise in specifications. Contractor shall submit planned pad dimensions based on received equipment data sheets. Pads shall extend a minimum of four inches beyond mounting frame of equipment and appropriately anchored with vibration isolators as specified elsewhere in this specification.

1.19 TESTS

- A. The Contractor shall supply all labor, materials, instruments and miscellaneous equipment for any examination of work or tests as required. All equipment and wire shall be satisfactorily tested and operated before placing in service. All test results shall be recorded and submitted to the Engineer.
- B. After the installation of equipment and wiring has been completed, test all electrical conductors to insure continuity, proper splicing, freedom from unwanted grounds, and acceptable insulation values. Furnish and use suitable instruments in making all tests. Preliminary checking with battery or magneto shall be permitted, but will not be accepted in obtaining final results which shall be obtained utilizing a "megger".
- C. At the completion of the work, completely test each system, and each and every part thereof, and adjust, repair or replace as necessary, to provide a complete workmanlike and operational installation to the satisfaction of the engineer and owner.
- D. Completely test all equipment installed as part of this contract. This includes all equipment furnished and installed by the electrical contractor as well as equipment furnished by others and installed by the electrical contractor and equipment furnished and installed by others and wired by the electrical contractor.
- E. Submit notice in writing 72 hours prior to testing, so that Owner or his Representative can make arrangements to be on site.
- F. Covered or concealed work shall remain exposed until tested and accepted.

- G. Operating and specified performance testing of components or systems shall be conducted in the presence of the Owner or his Representative.
- H. Certificates of approval and/or acceptance as specified or required by regulations of agencies having jurisdiction shall be submitted prior to acceptance of work.
- I. Retesting required because of non-conformance to specified requirements shall be performed by the same independent firm on instructions by the Architect/Engineer. Payment for retesting will be by the Contractor with no additional cost to the Owner.
- J. Test all equipment and wiring in accordance with the latest edition of the international Electrical Testing Association (NETA) Acceptance Testing Specifications (NETA-ATS). For each piece of equipment, perform testing as indicated for that equipment in the NETA-ATS. Where Equipment is not specifically listed in the NETA-ATS, perform testing based on the equipment listed which most closely resembles in the equipment to be tested. Perform all tests listed in the NETA-ATS, unless indicated otherwise. Tests indicated as "optional" in the NETA-ATS are not required unless specifically indicated otherwise on the drawings or specifications.
- K. All testing shall be performed by a NETA accredited independent testing firm employed by the electrical contractor, unless indicated otherwise.
 - 1. Electrical tests of panels, switchboards, switches, and circuit breakers rated 800A and less and 600V and less are not required, except that megger testing is required.
 - 2. Electrical tests of motors 100 HP and less are not required.
 - 3. Electrical tests of individual motor starters are not required. This does not apply to motor control centers (where applicable), where complete testing is required.
 - 4. Visual and mechanical checks are required for all equipment (including all panels, switchboards, switches, circuit breakers, motors, motor starters, and all other equipment) without exception.
- L. For all testing performed, submit complete typewritten and tabulated test results for review and approval by the engineer and owner. Submit test result bound together in a single three-ring binder (one (1) binder per set of test results). Submit quantity of sets as directed in the General Construction specifications, but in no case less than five (5) sets.
- M. Records of all torque wrench calibration and settings shall be provided.

1.20 SERVICE INTERRUPTIONS

- A. Electrical service is defined as any electrical, communication, data, fire alarm, and any other electrical transmission system. Other services include but are not limited to water, sanitary, gas, HVAC, stormwater systems.
- B. As a minimum, a start-up/energization plan shall be provided for new or modified electrical systems.
- C. The Contractor shall notify the Architect/Engineer and Owner of the intent to perform any work which requires service interruption and shall proceed with such work only after receiving a time schedule approved by the Architect/Engineer and Owner. The Owner shall have the right to cancel or delay the time of any service interruption. The Contractor shall provide personnel and equipment to assist in the proper coordination of service interruptions. The Contractor shall not leave the job site until resumption of normal service is satisfactory to the Owner.

- D. When shutdown of existing electrical facilities (including fire alarm, speaker, telephone, etc.) is required, shutdown shall be kept to an absolute minimum and coordinated with the Engineer. Temporary services shall be provided as required.
- E. Contractor shall perform all work involving service interruptions at times designated by the Owner. No allowances will be made by the Owner for overtime labor costs.
- F. Where Contractor interrupts any electrical or other service due to damaging equipment or cable through his negligence, he shall be required to repair or replace the equipment or cable immediately, working continuously to restore service until satisfactory to the Owner. Repair, replacement or both shall be at the discretion of the Architect/Engineer or Owner and at the expense of the Contractor.
- G. When work must be performed on energized equipment or circuits, use personnel experienced in such operations. Contractor shall provide proper personnel protective equipment per NFPA 70E and follow all codes.

1.21 TEMPORARY SERVICES

- A. Contractor shall provide temporary electrical and communication services due to work of this Contractor and work of all other Contractors throughout the entire work area. This includes connection to construction trailers. Contractor shall revise temporary services as many times as necessary for all work to occur through the completion of the project. The contractor is responsible for paying all installation costs.
- B. Building 237 construction power and Building 238 normal power shall be temporarily provided by the existing electrical service. Contractor to provide all required temporary equipment and conduit and wiring.
- C. Refer to applicable Division 1 specifications for additional temporary services responsibilities.
- D. Temporary lighting shall be provided to maintain an average of 40 F.C. and 20 amp 120 volt receptacles shall be provided at 50 foot intervals throughout the construction area as a base condition.

1.22 CUTTING AND PATCHING

- A. Cutting shall be done so as not to disturb the structural integrity of the existing building.
- B. Holes through floor slabs and walls shall be core-drilled.
- C. Cutting with impact type devices is prohibited.
- D. Patching shall be done so as to match the surrounding materials in strength and in appearance.
- E. Seal all openings in fire rated walls and floors with the rated penetration resistant sealant. For example, 3M Fire Barrier Caulk CP-25 or Putty 303.
- F. Where wall, ceiling, and floor slab penetrations are required to install new conduit, all surfaces must be restored to match existing finish.
- G. Refer to applicable Division 1 specification for additional requirements.

1.23 SLEEVES

- A. Each Contractor shall furnish all sleeves required for his work to the Prime Contractor for positioning into formwork.
- B. Sleeves shall be Schedule 40 steel pipe for piping or conduit penetrations. Seal voids between duct/pipe and sleeve with fire retardant insulation meeting ASTM Standards.
- C. Sleeves shall extend through construction. Finish flush with wall surfaces and extend three (3) inches above floors. Each sleeve shall provide for a minimum ½" clearance around pipe or its covering in the instance of pipe covered with insulation.
- D. Each fire-rated wall penetration shall be sealed with listed, fire-rated sealant and shall be located on as-built drawings and identified by the applicable UL directory file number.
- E. All sleeves in waterproof walls shall be fitted and sealed with positive hydrostatic "Link Seals" as manufactured by Thunderline Corporation. Sleeves shall be sized accordingly. Link Seals shall be placed around piping and/or conduit and inserted into void between inner wall of sleeve and piping and/or conduit. Tighten link seals as required for watertight seal. Where opening has not been cored cleanly, or in new construction, provide a properly sized sleeve set and weather proofed to prevent leakage.
- F. Voids between sleeves and piping, ductwork or conduit, where located in fire rated partitions or masonry walls shall be sealed with firestopping insulation and sealant as required to maintain the fire resistance rating of the partition.

1.24 RELOCATION OF EXISTING EQUIPMENT

- A. Contractor shall perform all relocation work required for completion of the electrical systems under this project.
- B. Where equipment is indicated to be relocated, the contractor shall modify/extend existing conduit and wiring as required to accommodate new location. Conduit and wiring to match specifications.
- C. Where work under this contract interferes with existing construction, ductwork, piping, conduit or equipment, remove all such materials and reroute such to clear the obstruction. Provide additional piping, conduits, ducts and materials of the same design and quality as required for continued use and operation.

PART 2 - SUBMITTALS

2.1 SUBMITTAL PROCEDURES

- A. Refer to Section 013300.
- B. Identify Project, Contractor, Subcontractor or supplier; pertinent drawing sheet and detail number(s), and specification section number, as appropriate.
- C. Apply Contractor's stamp, signed or initialed certifying that review, verification of products required, field dimensions, NEC code required clearance, adjacent construction work, and coordination of information, is in accordance with the requirements of the Scope of Work.
- D. Revise and resubmit submittals as required. Identify all changes made since previous submittal.

2.2 SUBSTITUTIONS

- A. Bids shall be submitted only on the basis of materials, products or equipment specified in the specifications, on the drawings, or as named by Addendum issued prior to bid date and pursuant to requests for approval.
- B. Materials, products or equipment specified in these specifications or on the drawing, are specified for the purpose of establishing a standard of quality, cost, design and function. It is not the intent to limit the acceptance of materials, products or equipment specified, but rather to name or describe a material, product or piece of equipment as the absolute minimum standard that is desired and acceptable. Where proprietary names are used, whether or not followed by the words "or approved equal", they shall be subject to equals only as preapproved by the Engineer prior to the date for receipt of bids.
- C. No substitutions shall be considered unless written requests are submitted to the Engineer for approval three (3) days prior to the date for receipt of bids. Such requests shall be from a Prime Contractor and shall include a complete description of the proposed substitute, documentary proof of equal or superior quality, drawings or catalog cuts clearly marking the models or lines, sample of materials, performance and test data, jobs completed locally within the past five years and any other data or information necessary for a complete evaluation.
- D. Approved substitutions will be set forth by Addenda to alert all bidders.
- E. The contract documents have been prepared to provide for the incorporation of the "Standard of Design and Construction" of the specified items or assemblies of every category of materials, products or pieces of equipment in the event that incorporation of a non "Standard of Design and Construction" item or assembly into the work will require revisions or additions to the contractual requirements of the Prime Contractor or any of his Sub-contractors, the Prime Contractor or Sub-contractor electing to use such item or assembly shall bear the cost of such revisions or additions to the work of all trades without change to the Contract sum. The first listed manufacturer is the "Standard of Design and Construction".
- F. If no prospective bidder has elected to obtain approval by the means described above, the Owner has no authority after award of contract, to consider any brand other than those named in the Contract Documents.
- G. A substitution submitted by a Contractor or Sub-contractor after the award of contract, for reason that a product is not available, will not be permitted unless proof is submitted that a firm order was placed within 15 days after Notice of Award to the Prime Contractor. If an order was placed as stated, and the product is not available, the Contractor shall submit a substitute product for review by the Owner and Engineer.

2.3 SHOP DRAWINGS

- A. Submittals shall be in accordance with requirements of Section 013300 SUBMITTALS.

2.4 PRODUCT DATA

- A. Submittals shall be in accordance with requirements of Section 013300 - SUBMITTALS
- B. Submit the following for review:

Project Schedule
Submittal Schedule
Sequence Plan

Service Interruption Request
Operation and Maintenance Manuals
Test Forms
Test Results
Overall Operational Testing
As-Built Drawing
Conduit
Building Wire and Cable
Low Voltage Termination's and Splices
Boxes
Wiring Devices and Plates
Cabinets and Enclosures
Ground System
Identification Products and Schedule
Circuit Breakers
Power Metering Systems
Safety Switches
Panelboards
Fuses
Light Fixtures
Fire Alarm System
Fire Alarm Cable
Security System
Communications Cable
Communication Cable Terminations and Splices
Intercom System
Others as Specified Elsewhere
Others as Requested

2.5 MANUFACTURER'S INSTRUCTIONS

- A. When specified in individual specification sections, submit manufacturers' printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, in quantities specified for product data.
- B. Identify conflicts between manufacturers' instructions and Contract Documents. Engineer shall make decision on which procedure will be followed.

2.6 MANUFACTURERS FIELD SERVICES AND REPORTS

- A. When specified in individual specification Section, product suppliers or manufacturers shall provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment as applicable, and to provide operating instructions when necessary.
- B. Report observations, and decisions, and/or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.
- C. Submit report in duplicate within 15 days of observation to Architect/Engineer for review.

2.7 MANUFACTURER'S CERTIFICATES

- A. When specified in individual specification sections, submit manufacturers' certificate to Engineer for review, in quantities specified for Product Data.
- B. Indicate that material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
- C. Certificates may be recent or previous test results on material or product, but must be acceptable to Engineer.

2.8 RECORD DRAWINGS

- A. At the completion of the work, Contractor shall provide the Engineer with a complete set of record Drawings.
- B. Contractor shall provide an electronic AutoCAD file of all project specific drawings.
- C. Indicate installed conditions for:
 - 1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; and circuit breaker size and arrangements.
 - 2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
 - 3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
- D. Show depths and locations of ends of duct banks measured from paving edges and/or other permanent objects. Provide digital pictures of duct bank crossings with other piping systems and at building entrances, prior to backfilling excavations.
- E. Locate conduit runs that deviate from point to point routing.
- F. Coordinate and cooperate with Engineer to make drawings provide an accurate record of the new installation.
- G. See Section 017000 for additional requirements.

PART 3 - CONTRACT CLOSE-OUT

3.1 GUARANTEES

- A. The Contractor shall furnish, before final payment, a written guarantee for this installation, substantially stating that all materials, equipment, fixtures and appurtenances, and the systems which they comprise are:
 - 1. Free from inherent defects or flaws in workmanship or operation.
 - 2. Functioning properly and capable of providing satisfactory operation in accordance with design conditions.
- B. Any defects in workmanship, defective materials, malfunction of equipment or unsatisfactory performance, and all other work damaged thereby, shall be repaired, replaced or otherwise remedied without expense to the Owner. Such repairs or replacements shall be made within reasonable time and the convenience of the Owner. Such guarantee shall be in effect for a period of one year from date of acceptance of the systems as a whole, except when a larger guarantee is required in contract documents.

3.2 CLOSEOUT

- A. Submit written certification that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents, revised shop drawings, approved change orders, and punch list items have been resolved to Engineer/Owner's satisfaction.
- B. Provide submittals to Engineer/Owner that are required by governing or other authorities, including but not limited to the following:
 - 1. Certificates of Substantial Completion.
 - 2. Operating and Maintenance Manuals.
 - 3. Guarantee/Warranty letters.
 - 4. Contractor's Affidavit of Release of Liens.
 - 5. Consent of Surety to reduction in or partial release of retainage.
 - 6. Consent of Surety to final payment.
 - 7. Contractor's Affidavit of Payment of debts and claims.
- C. When the job is complete, the Contractor shall request a final inspection in accordance with Section 017000. The Contractor shall accompany the Engineer throughout the inspection.
- D. The Contractor shall demonstrate the function of any equipment and system as requested. In the event that any equipment or system does not function correctly, the Contractor shall perform any tests and provide test equipment required to ascertain the cause.
- E. The Engineer will prepare a punch list of unacceptable items and present it to the Contractor. Reinspection will be done as soon as all items have been corrected.

3.3 OPERATION AND MAINTENANCE MANUALS FORMAT

- A. Prepare data in the form of an instructional manual.
- B. Binders: Commercial quality, 8-1/2 x 11 inch three-ring binders with hardback, cleanable, plastic covers; 3 inch maximum ring size. When multiple binders are used, correlate data into related consistent groupings.
- C. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; list title of Project and separate building; identify subject matter of contents.
- D. Arrange contents by systems under section numbers and sequence of Table of Contents of this Project Manual.
- E. Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
- F. Text: Manufacturer's printed data, or typewritten data on 20 pound paper.
- G. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
- H. Provide electronic copy of all Operation and Maintenance Manuals.

- I. Submitted: Submit an electronic copy for review 15 days prior to final inspection. This copy will be returned with Architect/Engineer comments. Revise as required. Submit three (3) final revised hard copies and an electronic copy within ten (10) days after final inspection

3.4 CONTENTS, EACH VOLUME

- A. Part 1: Table of Contents: Provide title of Project; names, addresses, and telephone numbers of Engineer, subconsultants, and Contractor with name of responsible parties; schedule of products and systems, indexed to content of the volume.
- B. Part 2: Operation and maintenance instructions, arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of subcontractors and suppliers. Identify the following:
 1. Significant design criteria.
 2. List of equipment.
 3. Parts list for each component.
 4. Operating instructions.
 5. Maintenance instructions for equipment and systems.
 6. Maintenance instructions for finishes, including recommended cleaning methods and materials and special precautions identifying detrimental agents.
- C. Part 3: Project documents and certificates, including the following:
 1. Shop drawings and product data.
 2. Certificates.
 3. Photocopies of warranties.
 4. Test Results.

3.5 MANUAL FOR EQUIPMENT AND SYSTEMS

- A. Each Item of Equipment: Include description of unit or system, and component parts. Identify function, normal operating characteristics, and limiting conditions. Include engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
- B. Provide electrical service characteristics, controls and communications.
- C. Include color coded wiring diagrams as installed.
- D. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shutdown, and emergency instructions.
- E. Maintenance Requirements: Include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- F. Provide servicing and lubrication schedule, and list of lubricants required.
- G. Include manufacturer's printed operation and maintenance instructions.
- H. Include sequence of operation by controls manufacturer.

- I. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- J. Provide control diagrams by controls manufacturer as installed.
- K. Provide list of original manufacturer's spare parts, and recommended quantities to be maintained in storage.
- L. Provide a listing in Table of Contents for design data, with tabbed fly sheet and space for insertion of data.

3.6 TRAINING

- A. Provide operation and maintenance training at Owner's facilities, as specified in individual sections. Training shall include explanation and demonstration of all functions, operations and maintenance procedures. Coordinate exact time and location with Engineer. Training shall be scheduled to train the Personnel as the equipment is coming on line. See Section 017000 for additional requirements.
- B. Training shall be provided for all new equipment or changes to existing system configuration/equipment.

END OF SECTION 260500

SECTION 260501
ELECTRICAL DEMOLITION

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 RELATED DOCUMENTS

- A. Applicable requirements of the Drawings, Owner/Contractor Agreement, General Conditions of Contract for Construction, Supplementary Conditions, Unified Facilities Criteria Standards, and Division 1 - General Requirements, are part of this Section and have the same force and effect as if printed herein in full.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.01 GENERAL

- A. This section shall apply to work associated with the demolition of all existing equipment except for equipment identified on the plans as existing to remain. Any circuiting, controls, etc., associated with equipment labeled "EXISTING TO REMAIN" shall be maintained.
- B. The existing feeder to Building 238 shall be reconfigured to connect to the Building 237 new main panelboard.
- C. Unless otherwise noted, all equipment within the areas to be renovated shall be removed.

3.02 COORDINATION

- A. The Owner may request that equipment be salvaged. The Electrical Contractor shall coordinate the salvaging of existing equipment with the Owner. This salvaged equipment shall be delivered to a location determined by the Owner.
- B. Prior to commencing demolition, the Electrical Contractor shall walk-thru the site with the Owner in order to confirm equipment to be demolished.
- C. All material not salvaged shall become the property of the contractor and shall be removed from the site for legal disposal off Owner's property. Materials determined to be salvageable shall be coordinated with the Owner and delivered to a location on Owner's property as directed.

3.03 DISCONNECTION OF POWER

- A. The Electrical Contractor shall be responsible for disconnecting power to all equipment in the renovated spaces. This includes, but is not limited to, panelboards, light fixtures, wiring devices, public address components, fire alarm equipment, mechanical equipment, plumbing equipment, motors and other power utilizing equipment. Refer to architectural demolition plans and specifications for areas being demolished. Refer to electrical, mechanical and plumbing plans for equipment being demolished.
- B. Disconnection of power includes removal of wires from the circuit breaker in the panelboard to the utilizing equipment. This includes all starters and control devices for the equipment. Disconnection shall also include removal of control wires to next device or control panel. Existing conduit may be reused if in conformance with these specifications and judged acceptable. Conduit not reused shall be removed.
- C. For circuits powering both equipment to remain and equipment to be demolished, the electrical contractor shall de-energize only that portion of the circuit being demolished. Remove portions of the circuit not in use. Update installation to insure compliance with applicable codes.
- D. Electrical Contractor shall be responsible for ascertaining that all work to be demolished is safe for other trades that remove the materials.

3.04 MAINTENANCE OF EXISTING SYSTEMS

- A. General: All existing systems shall be maintained throughout construction period. Provide temporary wiring and connections, as required, to maintain existing systems.
- B. Equipment shown on the plans as "EXISTING TO REMAIN" shall be maintained at all times, including circuiting.
- C. The contractor shall mark conduits that are to remain in place, with bright fluorescent tape. Tape shall be removed upon completion of demolition. All labeling and tagging shall be coordinated with the General Contractor. Equipment, fixtures, devices, and circuiting accidentally removed shall be immediately replaced or repaired to original condition.

3.05 PREPARATION

- A. When work must be performed on energized equipment or circuits, use personnel experienced in such operations. Contractor shall provide proper personnel protective equipment per NFPA 70E and follow all codes.
- B. Protect all existing equipment which is to remain in place, be reused, or remain the property of the Owner. Items which are damaged shall be repaired to their original condition or replaced with new.
- C. Where removals leave holes and damaged surfaces exposed in the finished work, patch and repair these holes and damaged surfaces to match adjacent finished surfaces. Where new finish is to be applied to existing surfaces, perform removals and patching in a manner to produce surfaces suitable for receiving new work. Holes and depressions shall be completely filled with an approved patching material; material shall be applied in accordance with the manufacturer's printed instructions.
- D. Boxes that are abandoned in place shall be provided with a solid/blank abandonment cover.

END OF SECTION 260501

SECTION 260503
EQUIPMENT WIRING SYSTEMS

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 RELATED DOCUMENTS

- A. Applicable requirements of the Drawings, Owner/Contractor Agreement, General Conditions, Unified Facilities Criteria Standards, Supplementary Conditions, and Division 1 - General Requirements, are part of this Section and have the same force and effect as if printed herein in full.

1.03 SECTION INCLUDES

- A. Electrical connections to equipment specified under other sections.

1.04 SCOPE

- A. Wiring connections to all power utilizing and control equipment specified under other sections shall be included as a part of this work. Refer to other divisions within these specifications for equipment requirements.
- B. The connections shall include motor starters, disconnect switches, and required overcurrent protection for proper operation of equipment.

1.05 RELATED SECTIONS

- A. Division 22: Plumbing Equipment.
- B. Division 23: Mechanical Equipment.
- C. Section 083323 - Overhead coiling doors.

1.06 REFERENCES

- A. NEMA WD 1 - General Requirements for Wiring Devices.
- B. NEMA WD 6 - Wiring Device – Dimensional Requirements.
- C. ANSI/NFPA 70 - National Electrical Code.

1.07 SUBMITTALS

- A. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.
- B. Project Record Documents: Record actual locations, sizes, and configurations of equipment connections.

1.08 COORDINATION

- A. Coordinate work with all other contractors.
- B. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other divisions prior to ordering or installing any materials required for connection to equipment. Supply power to equipment including necessary disconnecting means and overcurrent protection
- C. Determine connection locations and requirements.
- D. Sequence rough-in of electrical connections to coordinate with installation of equipment.
- E. Sequence electrical connections to coordinate with start-up of equipment.
- F. Unless otherwise specified herein, it is the intent of this Division to provide all electrical connections required to protect, properly operate, and control all motors, appliances, electrical devices, and equipment furnished and installed under this and other Divisions of the specifications or shown on the drawings. Refer to Equipment Schedule or drawings.

1.09 MECHANICAL EQUIPMENT

- A. The mechanical contractor will provide all motors, automatic switches, and controls for all equipment installed under Division 23.
- B. All automatic switches, motor control, and line voltage controls supplied by the Mechanical Contractor shall be installed and wired by the Electrical Contractor.
- C. All control wiring for plumbing and heating, ventilating and air conditioning systems shall installed under Division 22 and 23. Review Division 22 and 23 Specifications and shop drawings for control systems to assure compatibility between equipment furnished under Division 26 and wiring furnished under Divisions 22 and 23.
- D. All disconnects and switches shown on electrical drawings for mechanical equipment shall be provided by the electrical contractor unless otherwise noted.

PART 2 – PRODUCTS

2.01 CORDS AND CAPS

- A. Attachment Plug Construction: Conform to NEMA WD 1.
- B. Configuration: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
- C. Cord Construction: ANSI/NFPA 70, Type SJO multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.

- D. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations and connections to air handling units and pumps.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet where connection with attachment plug is indicated.
- E. Provide cord and cap where field-supplied attachment plug is indicated.
- F. Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices as required.
- H. Modify equipment control wiring with terminal block jumpers as indicated.
- I. Provide interconnecting conduit and wiring between devices and equipment where indicated.

END OF SECTION 260503

SECTION 260519
LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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. Applicable requirements of the Drawings, Owner/ Contractor Agreement, General Conditions of Contract for Construction, Unified Facilities Criteria Standards, Supplementary Conditions, and Division 1 - General Requirements, are part of this Section and have the same force and effect as if printed herein in full.

1.3 SECTION INCLUDES

- A. Building wire and cable for wiring systems rated 600 volts and less.
- B. Wiring connectors and connections.

1.4 RELATED SECTIONS

- A. Section 260532 – Boxes
- B. Section 260533 – Raceways
- C. Section 260503 - Electrical Identification

1.5 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code.
- B. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
- C. ASTM: American Society for Testing and Materials
 - 1. B 3-80, Soft or Annealed Copper Wire.
 - 2. B 8-77, Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
- D. U.L.: Underwriters Laboratories, Inc.
 - 1. U.L 83 - Wires Thermoplastic-Insulated.
 - 2. U.L. 486A - Wire Connectors and Soldering Lugs for use with Copper Connectors.
- E. NEMA: National Electrical Manufacturers' Association.

1. WC 5 - Thermoplastic Insulated Wire & Cable.
2. WC 30 - Color Coding of Wires and Cables.
3. WC 70/ICEA S-95-658

1.6 SUBMITTALS

- A. Product Data: Provide manufacturers standard documentation. Data must include information required to determine conformance with specifications.
- B. Samples: 2'-0" samples with the wire size, voltage rating, insulation type, and manufacturer's name identified shall be submitted as requested.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver wire and cable according to NEMA WC-26.

1.8 PROJECT CONDITIONS

- A. Conductor sizes are based on copper. Aluminum conductors shall not be installed on this project.
- B. Wire and cable routing shown on drawings is approximate unless dimensioned. Route wire and cable as required to meet project conditions.
- C. Where wire and cable routing is not shown, and only destination is indicated, determine exact routing and lengths required in conformance with the Division 26 specifications.

1.9 QUALITY ASSURANCE

- A. Provide wiring materials located in plenums with peak optical density not greater than 0.5, average optical density not greater than 0.15, and flame spread not greater than 5 feet (1.5 m) when tested in accordance with NFPA 262.

1.10 COORDINATION

- A. Determine required separation between cable and other work.
- B. Determine cable routing to avoid interference with other work.
- C. Coordinate layout and installation of cable with other installations. Revise locations as required to suit field conditions.

PART 2 - PRODUCTS

2.01 BUILDING WIRE AND CABLE

- A. Description: Single, annealed, conductor, insulated wire; 98% conductivity at 20°C. Wires and cables manufactured more than 12 months prior to date of delivery to site shall not be used.

- B. Conductor: Copper. Use of aluminum conductors is unacceptable. Temporary wire and cables shall be copper.
- C. Insulation Voltage Rating: 600 volts.
- D. Insulation Temperature Rating: 90° C.
- E. Wiring Methods: Provide the following wiring methods:
 - 1. Dual rated THHN/THWN-2 or XHHW-2 insulation.
 - 2. Cable Tray Locations: Use only Tray cable Type TC.
 - 3. Provide ground wire for all branch circuits and feeders.
 - 4. All wire shall be run in conduit.
- F. Standards: IPCEA - NEMA Standard, S-19-81 and ASTM D-1352
- G. Use solid conductor for feeders and branch circuits 10 AWG and smaller; larger conductors shall be stranded.
- H. Use stranded conductors for all control and communication circuits.
- I. High Temperature Areas: Wire installed in areas and locations subject to temperature unsafe for the thermoplastic insulation shall be heat resistant and be type V, FEP, TFE, SA or Z as required.

2.02 CONNECTORS AND SPLICES

- A. UL-Listed, factory-fabricated, wiring connectors of size, ampacity rating, material, type, and class for application and for service indicated. Cable termination lugs shall be compression type. Select to comply with requirements as specified in Part 3 "Execution".
- B. All low voltage cable splices in manholes or handholes shall be made using approved kits from Tyco, 3M, Polaris or Elastimold.

2.03 COLOR CODING

- A. 120/240V, 1 Phase: Black, red, white, green.
- B. 120/208V, 1 or 3 Phase: Black, Red, Blue, White, and Green.
- C. 277/480V, 3 Phase: Brown, Orange, Yellow, Gray, and Green.
- D. Isolated Ground Conductors: Green with yellow tracer(s).
- E. If the existing building's color coding standard differs from above, match existing. Otherwise, use the system indicated.

2.04 WIRE PULLING LUBRICANT

- A. Pulling tension calculations shall be performed to confirm that the allowable (per code or manufacturer requirements) pulling tension and side wall bearing pressure is not exceeded. Either of the following lubricants may be used provided that the products are deemed acceptable by the cable manufacturer. The contractor is responsible for coordinating with the cable manufacturer and obtaining in writing a statement from the cable manufacturer that the proposed lubricant is

acceptable for use with the proposed cable. Failure to do so may involve the contractor replacing cables at no additional cost to the owner. Products that may be incorporated in the work include:

1. Polywater J
2. Aquagel

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that mechanical work likely to damage wire and cable has been completed.
- C. Verify raceway installation is complete and supported.

3.02 INSTALLATION

- A. Install wires and cables as indicated, according to manufacturer's written instructions and the NECA standard of installation.
- B. Remove existing wires from raceway before pulling in new wire and cable.
- C. Pull all conductors into each conduit/raceway at same time.
- D. Use pulling means including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- E. Use conductor not smaller than 12 AWG for power and lighting circuits.
- F. Use conductor not smaller than 14 AWG for Class 1 control circuits and 16 AWG for Class 2 control circuits.
- G. Unless otherwise noted, use 12 AWG conductors for 20 ampere, 120 volt branch circuits up to 75 ft. in length and #10 AWG for longer circuits.
- H. Unless otherwise noted, use 12 AWG conductors for 20 ampere, 277 volt branch circuits up to 200 ft. in length and #10 AWG for longer circuits.
- I. Use suitable wire pulling lubricant for building wire 4 AWG and larger.
- J. Protect exposed cable from damage.
- K. Use suitable cable fittings and connectors.
- L. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- M. Clean conductor surfaces before installing lugs and connectors.
- N. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

- O. All splices, including low voltage or Class 2 wiring, shall be made in suitable enclosures or boxes.
- P. For wiring #8 AWG and larger, splices and taps shall be made utilizing suitable crimp-on compression connectors. Bolted type connectors shall not be utilized except that suitable split-bolt connectors may be utilized where combinations of wiring to be spliced do not correspond to compression type connector configurations. Connections shall be wrapped with rubber tape of type, thickness, and insulation level equal to 150% of wire insulation. The splice shall then be over wrapped with suitable vinyl insulating tape.
- Q. Use solderless pressure connectors with insulating covers for copper conductors splices and taps, 8 AWG and smaller.
- R. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller. Connections shall be over wrapped with vinyl insulating tape.
- S. Where stranded wiring #10 AWG and smaller terminates at equipment or devices, utilize suitable crimp on "Staconn" terminals. Where equipment terminals include pressure pads, wiring may terminate directly at terminals without the use of crimp-on terminals.
- T. Where solid wiring #10 AWG and smaller terminates at equipment or devices, wiring shall terminate directly at terminals.
- U. Where wiring #8 AWG and larger terminates at equipment, utilize suitable crimp-on compression lugs. Where equipment is provided with factory installed lugs, wiring may terminate directly at factory lugs.
- V. Color code conductors in accordance with the NEC and local requirements. Conductors smaller than No. 6 shall have continuous insulation color. Larger conductors shall be color coded by the application of at least 5 laps of tape at all points of access to conductors. Paint shall not be used for color coding of conductors.
- W. Identify wire and cable under provisions of Section 26 05 53.
- X. Connections to equipment shall be made in accordance with manufacturer's requirements. When torquing requirements are not indicated, tighten connectors and terminals according to UL standard 486A.
- Y. Exposed cable shall be installed parallel and perpendicular to surfaces or exposed structural members and follow surface contours where possible.
- Z. A separate neutral conductor shall be provided with each branch circuit when a neutral is required. Multiwire branch circuits with a shared common neutral shall not be utilized, unless specifically indicated otherwise on the drawings. If a shared neutral is provided in electrified furniture, a common neutral of #10 minimum size shall be provided in the branch circuit(s).
- AA. Multiple branch wiring circuits may be installed in the same raceway where permitted by code and provided all of the following conditions are met:
 - 1. Appropriate NEC derating factors shall be applied and conductor sizes adjusted as required.
 - 2. No conductor (after derating adjustment) shall exceed #10 AWG, except grounding conductors as provided below.
 - 3. A single equipment grounding conductor shall be permitted in lieu of individual equipment grounding conductors for each individual circuit. Isolated grounding conductors required for any circuit shall be in addition to the single equipment grounding conductor and shall be provided individually.

4. Conduit fill (after derating adjustment) shall not exceed 75% of the maximum number allowed by code.

BB. Wiring in plenum shall be in accordance with NEC requirements.

3.03 FIELD QUALITY CONTROL

- A. Testing: Upon installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 1. Procedures: Perform test stated in NETA Standard Acceptance Testing Specifications for all wires #6 and larger. Document all results; submit results and certify compliance with test parameters. Wires failing to meet requirements shall be replaced at no additional cost.

END OF SECTION 260519

SECTION 260526
GROUNDING AND BONDING

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 RELATED DOCUMENTS

- A. Applicable requirements of the Drawings, Owner/Contractor Agreement, General Conditions of Contract for Construction, Unified Facilities Criteria Standards, Supplementary Conditions, and Division 1 - General Requirements, are part of this Section and have the same force and effect as if printed herein in full.

1.03 DESCRIPTION

- A. This Section includes solid grounding and bonding of electrical systems and equipment. It includes basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented by requirements in other sections of these Specifications.

1.04 SECTION INCLUDES

- A. Grounding electrodes and conductors.
- B. Equipment grounding conductors.
- C. Bonding.

1.05 SUBMITTALS

- A. Product data: Provide manufacturer's standard catalog cuts for all items mentioned herein; including ground rods, connectors, connection materials and fittings. Data must include information required to determine conformance with specifications.
- B. Field-testing organization certificate, signed by the Contractor, certifying that the organization performing field tests complies with the requirements specified in Quality Assurance below.
- C. IEEE 1100 - Powering and grounding sensitive electronic equipment
- D. Report of field tests and observations certified by the testing organization.
- E. Manufacturer's Installation Instructions: Submit for active electrodes.

1.06 REFERENCES

- A. NFPA 70 - National Electrical Code.
- B. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
- C. IEEE 1100 - Recommended Practice for Powering and Grounding Electronic Equipment.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- E. UL 467 - Grounding and Bonding Equipment.
- F. Field-Testing Organization Qualifications: To qualify for acceptance, the independent testing organization must demonstrate, based on evaluation of organization-submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct satisfactorily the testing indicated.

1.07 SYSTEM DESCRIPTION

- A. Grounding systems use the following elements as grounding electrodes:
 - 1. Metal underground water pipe.
 - 2. Metal building frame.
 - 3. Metal underground gas piping system.

1.08 PROJECT RECORD DOCUMENTS

- A. Submit accurate records of actual locations of grounding electrodes and wells.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements specified herein and indicated on the plans, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following:
 - 1. Erico, Inc. (Basis of Design)
 - 2. Chance Co.
 - 3. O-Z/Gedney Co.
 - 4. Raco, Inc.
 - 5. Thomas & Betts Corp.
 - 6. Apache Grounding/Erico Inc
 - 7. Cadweld
 - 8. Thermoweld
 - 9. Burndy
 - 10. Or equal as approved by the Professional

2.02 GENERAL

- A. Products: Of types indicated and of sizes and ratings to comply with NEC. Where types, sizes, ratings, and quantities indicated exceed NEC requirements, the more stringent requirements and the greater size, rating, and quantity indicated shall be installed.
- B. All material shall be non-ferrous copper. Aluminum is not acceptable.

2.03 CONNECTORS

- A. General: Listed and labeled as grounding connectors for the materials used.
- B. Mechanical Connectors: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.
- C. Exothermic Welded Connections: Provided in kit form and selected for the specific types, sizes, and combinations of conductors and other items to be connected.

2.04 WIRE

- A. Grounding Electrode Conductor: Bare stranded tinned copper cable conforming to ASTM B-8 and ASTM B-33. Minimum cable size to meet NFPA 70 requirements. Conductor to be 4/0 AWG 30 Ft. drawn stranded bare copper cable. Or copper conductor insulated.
- B. Bonding Conductor: Copper conductor insulated.
- C. Equipment Grounding Conductor:
 - 1. Green Insulated copper cable in accordance with Section 260519 - "Wire and Cable" requirements. Minimum size to meet NFPA 70 requirements, unless larger size noted on plans or specified herein.
 - 2. Isolated Power System: Type XHHW insulation with a dielectric constant of 3.5 or less.

2.05 ROD ELECTRODE

- A. Copper-clad steel with high-strength steel core and electrolytic-grade copper outer sheath, molten welded to core. Size: 10' x 3/4" ground rod.

2.06 GROUNDING WELL COMPONENTS

- A. Box and Cover: 1'-0" x 1'-0" x 1'-0" open bottom reinforced polymer concrete box (2 each) stacked and removable bolt-on cover. Cover shall be embossed with the legend "GROUND".

2.07 MISCELLANEOUS CONDUCTORS

- A. Ground bus: Bare annealed copper bars of rectangular cross section noted on plans.
- B. Bus Bar Insulator: Fiber glass reinforced polyester insulator with 2 inch diameter threaded holes at both ends for bus bar installation.
- C. Braided Bonding Jumpers: Copper tape, braided No. 30 gage bare copper wire, terminated with copper ferrules.

- D. Bonding Strap Conductor/Connectors: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.

PART 3 – EXECUTION

3.01 APPLICATION

- A. Equipment Grounding Conductor Application: Comply with NEC Article 250 for sizes and quantities of equipment grounding conductors, except where larger sizes or more conductors are indicated.
 - 1. Install separate insulated equipment grounding conductors with all circuits. In conduits containing multiple circuits, a single equipment grounding conductor shall be permitted in lieu of several grounding conductors.
 - 2. Isolated grounding conductors required for any circuit shall be in addition to the equipment grounding conductor. A separate isolated ground conductor will be provided with each circuit.
 - 3. Water Heater Circuits: Install separate insulated equipment ground conductor to each electric water heater. Bond this conductor to heater units, piping, and connected equipment and components.

3.02 INSTALLATION

- A. General: Ground electrical systems and equipment including but not limited to metallic conduits, pole supports, transformers, cabinets, service equipment, panels, etc. in accordance with NEC requirements except where the Drawings or Specifications exceed NEC requirements.
- B. Ground Rods: The maximum resistance measured in accordance with IEEE No. 142 of a driven ground shall be reported to the engineer. If this resistance is too high, additional rods shall be added, or if sectional type rods are used, additional sections may be coupled and driven with the first rods. As a minimum, provide the number of rods shown on the drawing. Interconnect ground rods with a ground loop consisting of grounding conductor, minimum 4/0 AWG soft-drawn stranded bare copper cable. Interconnect ground rods with bare conductor buried at least 30 inches below grade. Connect bare-cable ground conductors to ground rods by means of exothermic welds except as otherwise indicated. Make these connections without damaging the copper coating or exposing the steel. Connect to the ground loop as shown on drawings. Drive rods until tops are minimum 6 inches below finished floor or final grade except as otherwise indicated. Verify final backfill and compaction has been completed before driving rod electrodes.
- C. Route grounding conductors along the shortest and straightest paths possible without obstructing access or placing conductors where they may be subjected to strain, impact, or damage, except as indicated.
- D. Bond interior metal piping systems and metal air ducts to equipment ground conductors of pumps, fans, electric heaters, and air cleaners serving individual systems.
- E. Grounding: Except where specifically indicated otherwise, all exposed noncurrent carrying metallic parts of electrical equipment, metallic raceway systems, ground bus, grounding conductor in nonmetallic raceways, and neutral conductor of the wiring system shall be grounded.
- F. Test Wells: Locate as indicated, and install in accordance with details indicated. Or Install grounding well pipe with cover at rod locations as indicated on Drawings.
- G. Ground Cable Crossing Expansion Joints in Structures and Pavements: Protect from damage by means of suitable approved devices or methods of installation which will allow the necessary slack

in the cable across the joint to permit movement. Use stranded or other approved flexible copper cable run or jumper across such separations.

H. Equipment Grounding

1. Metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be grounded for personnel safety and to provide a low impedance path for possible ground fault currents.

3.03 CONNECTIONS

- A. General: Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
1. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer in order of galvanic series.
 2. Make connections with clean bare metal at points of contact.
 3. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.
- B. Exothermic Welded Connections: Use for connections to underground connections; install at connections to all ground rods. Comply with manufacturer's written recommendations. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Grounding system connectors used in exposed work may be mechanical type, listed for use in grounding applications.
- D. Terminate insulated equipment grounding conductors for feeders and branch circuits with pressure-type grounding lugs. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Bond electrically noncontinuous conduits at both entrances and exits with grounding bushings and bare grounding conductors.
- E. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A.
- F. Compression-Type Connections: Use hydraulic compression tools to provide the correct circumferential pressure for compression connectors. Use tools and dies recommended by the manufacturer of the connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on the ground conductor.
- G. Moisture Protection: Where insulated ground conductors are connected to ground rods or ground buses, insulate the entire area of the connection and seal against moisture penetration of the insulation and cable.
- H. Connections at Test Wells: Use compression-type connectors on conductors and make bolted and clamped-type connections between conductors and ground rods.

3.04 BONDING JUMPERS

- A. Braided-Type Bonding Jumpers: Install to connect ground clamps on water meter piping to bypass water meters electrically. Use elsewhere for flexible bonding and grounding connections.

3.05 FIELD QUALITY CONTROL

- A. Independent Testing Organization: Arrange and pay for the services of a qualified independent electrical testing organization to perform tests described below.
 - B. Tests: Subject the completed grounding system to a megger test at service disconnect enclosure ground terminal and separately derived systems. Measure ground resistance without the soil being moistened by any means other than natural precipitation or natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the 2-point method in accordance with Section 9.03 of IEEE 81, "Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System."
 - C. Perform ground resistance and continuity testing in accordance with IEEE 142.
 - D. Perform ground continuity and functional tests:
 - 1. From main switchgear to grounding electrode and/or cold water main.
 - 2. Between each main secondary feeder switchboard ground and its termination point (distribution panels, panelboards, electric heater disconnects, and other such equipment) and all feeders shown on single line diagram.
 - 3. Between each distribution panel to panelboards and between each panelboard to panelboard (excluding branch circuits).
 - 4. Test each branch circuit receptacle for proper polarity and ground using a plug-in test device.
- Ground/resistance maximum values shall be as follows:
- 1. Low-Voltage Building Service (500 kVA or less): Less than 10 ohms.
- E. Deficiencies: Where ground resistances exceed specified values, and if directed, modify the grounding system to reduce resistance values. Where measures are directed that exceed those indicated the provisions of the Contract covering changes will apply.
 - F. Report: Prepare test reports of the ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

3.06 CLEANING AND ADJUSTING

- A. Restore surface features at areas disturbed by excavation and reestablish original grades except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other Work to their original condition. Include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching.

END OF SECTION 260526

SECTION 260529
HANGERS AND SUPPORTS

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. Applicable requirements of the Drawings, Owner/ Contractor Agreement, General Conditions of Contract for Construction, Supplementary Conditions, Unified Facilities Criteria Standards and Division 1 - General Requirements, are part of this Section and have the same force and effect as if printed herein in full.

1.3 SECTION INCLUDES

- A. Support from the building structure for electrical items by means of hangers, supports, formed steel channels, spring steel clips, anchors, sleeves, inserts, seals, firestopping, equipment bases and supports and associated fastenings.

1.4 RELATED SECTIONS

- A. Section 033000 - Cast-In-Place Concrete: Product requirements for concrete for placement by this section.
- B. Refer to individual Division 26 sections for additional specific support requirements.

1.5 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code.
- B. ASTM - American Society for Testing and Materials.
- C. UL - Underwriters Laboratories.
- D. NECA - National Electrical Contractors Association Standard of Installation.

1.6 DEFINITIONS

- A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.7 SYSTEM DESCRIPTION

- A. Firestopping Materials: UL 263 AND UL 1479 to achieve fire ratings as noted on architectural Drawings for adjacent construction, but not less than 1 hour fire rating.
- B. Firestop interruptions to fire rated assemblies, materials, and components.

1.8 PERFORMANCE REQUIREMENTS

- A. Firestopping: Conform to applicable code, FM and UL for fire resistance ratings and surface burning characteristics.
- B. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.
- C. All supporting devices shall be used for the specific purpose for which they were manufactured.

1.9 SUBMITTALS

- A. Product Data: Provide manufacturer's standard documentation for the following:
 - 1. Each type hanger, support, sleeve, seal, and fastener to be used.
 - 2. Firestopping: Submit data on product characteristics, performance and limitation criteria.
- B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
- C. Product Data:
 - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
 - 2. Each type sleeve, seal, and fastener to be used.
 - 3. Firestopping: Submit data on product characteristics, performance and limitation criteria.
- D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.
- E. Design Data: Indicate load carrying capacity of trapeze hangers and hangers and supports.
- F. Manufacturer's Installation Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.
 - 2. Firestopping: Submit preparation and installation instructions.
- G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- H. Engineering Judgements: For conditions not covered by UL or WH listed designs, submit judgements by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.
- I. Shop drawings indicating details of fabricated products and materials.

1.10 QUALITY ASSURANCE

- A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 or ASTM E814 with 0.10 inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
 - 1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
 - 1. Roof Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
 - a. Floor Penetrations Within Wall Cavities: T-Rating is not required.
- B. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.
 - 1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
 - 2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.
- C. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.
- D. Fire Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.
- E. Surface Burning Characteristics: Maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

1.11 ENVIRONMENTAL REQUIREMENTS

- A. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.
- B. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.
- C. Provide ventilation in areas to receive solvent cured materials.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
 - 1. Conduit Supports:
 - a. Allied Tube & Conduit (Basis of Design)
 - b. Electroline Manufacturing Company
 - c. O-Z Gedney
 - d. Or equal as approved by the Professional
 - 2. Formed steel channels:
 - a. Allied Tube & Conduit (Basis of Design)
 - b. B-Line Systems, Inc.

- c. Unistrut Diversified Products.
 - d. Or equal as approved by the Professional
- 2. Conduit Sealing Bushings:
 - a. Cooper Industries, Inc. (Basis of Design)
 - b. O-Z Gedney
 - c. Raco Inc.
 - d. Thomas & Betts Corp.
 - e. Or equal as approved by the Professional

2.2 GENERAL

- A. All supporting devices shall be used for the specific purpose for which they were manufactured. Provide materials, sizes and types of anchors, fasteners and supports to carry the loads of the equipment and conduit.

2.3 COATINGS

- A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for outdoor use shall be hot-dip galvanized after fabrication.

2.4 MANUFACTURED SUPPORTING DEVICES

- A. Conduit Supports:
 - 1. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.
 - 2. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.
 - 3. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.
 - 4. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.
 - 5. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self locking.
- B. Fasteners: Types, materials, and construction features as follows:
 - 1. Expansion Anchors: Carbon steel wedge or sleeve type.
 - 2. Toggle Bolts: All steel spring head type.
 - 3. Powder-Driven Threaded Studs: Powder – Driven devices shall not be used for this project.
- C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, passing through concrete floors and walls. Construct body of malleable-iron casting with hot-dip galvanized finish.
- D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casing with hot-dip galvanized finish.
- E. Formed steel channel: 12-gage steel channels with holes 1-1/2 inches on center. Exterior or wet locations, channel shall be PVC coated. Provide fittings and accessories that mate and match with channel and are of the same manufacture. Channel and spring steel clips shall be provided for racking of conduits and supporting of equipment as necessary.

FABRICATED SUPPORTING DEVICES

- A. General: Shop or field-fabricated supports or manufactured supports assembled from channel components.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

2.5 FIRESTOPPING

- A. Manufacturers:
 - 1. Dow Corning Corp. (Basis of Design)
 - 2. Fire Trak Corp.
 - 3. Hilti Corp.
 - 4. 3M fire Protection Products
 - 5. Or equal as approved by the Professional
- B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
 - 1. Silicone Firestopping Elastomeric Firestopping: Single component silicone elastomeric compound and compatible silicone sealant.
 - 2. Foam Firestopping Compounds: Single component foam compound.
 - 3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
 - 4. Fiber Stuffing and Sealant Firestopping: Composite of mineral or ceramic fiber stuffing insulation with silicone elastomer for smoke stopping.
 - 5. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
- C. Color: As selected from manufacturer's full range of colors.

2.6 FIRESTOPPING ACCESSORIES

- A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.
- B. Dam Material: Permanent:
 - 1. Mineral fiberboard.
 - 2. Mineral fiber matting.
- C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.
- D. General:
 - 1. Furnish UL listed products.
 - 2. Select products with rating not less than rating of wall or floor being penetrated.
- E. Non-Rated Surfaces:
 - 1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where conduit is exposed.
 - 2. For exterior wall openings below grade, furnish modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill annular space between conduit and cored opening or water-stop type wall sleeve.

2.7 VIBRATION ISOLATORS

- A. Double deflection, resilient type
 - 1. Use for floor mounted equipment and all transformers
 - 2. Oil/Water resistant neoprene material
 - 3. Ribbed faces for non-bolted applications
 - 4. Bolt holes for bolted applications
- B. Spring isolators – freestanding, laterally stable, open type
 - 1. Use for generators.
 - 2. Use internally, between base and core and coil assembly for all substation transformers.
 - 3. Sized to support 200% of rated load.

2.8 SLEEVES

- A. Sleeves shall be Schedule 40 steel pipe for piping or conduit penetrations. Seal voids between duct/pipe and sleeve with fire retardant insulation meeting ASTM Standards.
- B. Sleeves shall extend through construction. Finish flush with wall surfaces and extend three (3) inches above floors. Each sleeve shall provide for a minimum 1" clearance around pipe or its covering in the instance of pipe covered with insulation.
- C. All sleeves in waterproof walls shall be fitted and sealed with positive hydrostatic "Link Seals" as manufactured by Thunderline Corporation. Sleeves shall be sized accordingly. Link Seals shall be placed around piping and/or conduit and inserted into void between inner wall of sleeve and piping and/or conduit. Tighten link seals as required for watertight seal. Where opening has not been cored cleanly, or in new construction, provide a properly sized sleeve set and weather proofed to prevent leakage.
- D. Voids between sleeves and piping, ductwork or conduit, where located in fire rated partitions or masonry walls shall be sealed with firestopping insulation and sealant as required to maintain the fire resistance rating of the partition.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.
- B. Coordinate with the building structural system and with other divisions.
- C. Raceway Supports: Comply with the NEC and the following requirements:
 - 1. To comply with DoD minimum antiterrorism standards for buildings, Design all equipment mountings to resist forces of 0.5 times the equipment weight in any horizontal direction and 1.5 times the equipment weight in the downward direction
 - 2. Conform to manufacturer's recommendations for selection and installation of supports.
 - 3. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs, provide additional strength until there is a minimum of 200 lbs safety allowance in the strength of each support.

4. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
 5. Support parallel runs of horizontal raceways together on trapeze-type hangers.
 6. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2 inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4 inch diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
 7. Install conduit and raceway support and spacing in accordance with NEC.
 8. Support exposed and concealed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.
 9. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
 10. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
- D. Vertical Conductor Supports: Install simultaneously with installation of conductors.
- E. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices. Walls of light weight construction (including all stud/drywall type construction) shall be reinforced with surface mounted continuous steel support channels (Unistrut) before hanging electrical equipment.
- F. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.
- G. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and walls for raceways and cable installations. For sleeves through fire rated wall or floor construction, apply UL-listed firestopping sealant in gaps between sleeves and enclosed conduits and cables.
- H. Conduit Seals: Install seals for conduit penetrations of slabs on grade, exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.
- I. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:
1. Use wood screws: Wood construction.
 2. Toggle Bolts: Hollow tile, terra cotta, hollow masonry units, lathe construction.
 3. Concrete inserts or expansion bolts: Concrete or brick. Fasteners attached to concrete ceiling shall be vibration and shock resistant. Holes cut in concrete shall not cut reinforcing bars. Fill unused holes.
 4. Machine Screws, welded threaded studs or spring-tension clamps: Steel work.
 5. Sheet Metal Screws: Use in partitions of light steel construction only.
 6. Do not weld conduit or pipe straps to steel structure.

7. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load.
8. Walls of light weight construction shall be reinforced to provide adequate support for equipment mounting.

J. INSTALLATION – FIRESTOPPING

1. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, conduit and other items, requiring firestopping.
2. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.
3. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating to uniform density and texture.
4. Compress fibered material to maximum 40 percent of its uncompressed size.
1. Place foamed material in layers to ensure homogenous density, filling cavities and spaces. Place sealant to completely seal junctions with adjacent dissimilar materials.
1. Place intumescent coating in sufficient coats to achieve rating required.
2. Remove dam material after firestopping material has cured.
3. Fire Rated Surface:
 - a. Seal openings as follows:
 - (1) Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element, floors shall be 2".
 - (2) Size sleeve allowing minimum of 1 inch void between sleeve and building element.
 - (3) Pack void with backing material.
 - (4) Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
 - b. Where conduit penetrates fire rated surface, install firestopping product in accordance with manufacturer's instructions.

K. Non-Rated Surfaces:

- c. Seal opening through non-fire rated opening as follows:
 - (1) Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element, floors shall be 2".
 - (2) Size sleeve allowing minimum of 1 inch void between sleeve and building element.
 - (3) Install type of firestopping material recommended by manufacturer.
- d. Install escutcheons, floor plates, or ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
- e. Exterior wall openings below grade: Assemble rubber links of mechanical seal to size of conduit and tighten in place, in accordance with manufacturer's instructions.
- f. Interior partitions: Seal pipe. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

L. INSTALLATION - EQUIPMENT BASES AND SUPPORTS

1. Provide housekeeping pads of concrete, minimum 4 inches thick and extending 4 inches beyond supported equipment. Refer to Section 03 30 00.
2. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.

END OF SECTION 260529

SECTION 260532

BOXES

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 RELATED DOCUMENTS

- A. Applicable requirements of the Drawings, Owner/ Contractor Agreement, General Conditions, Unified Facilities Criteria Standards, Supplementary Conditions, and Division 1 - General Requirements, are part of this Section and have the same force and effect as if printed herein in full.

1.03 SECTION INCLUDES

- A. Outlet Boxes.
- B. Junction Boxes.
- C. Pull Boxes.
- D. Conduit Bodies.

1.04 RELATED SECTIONS

- A. Section 262726 - Wiring Devices.
- B. Section 260529 – Hangers and Supports.

1.05 REFERENCES

- A. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
- B. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
- C. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
- D. ANSI/NFPA 70 - National Electrical Code.
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- F. UL 886 - Outlet Boxes and Fittings for Use in Hazardous Locations.
- G. UL 50 - Cabinets and Boxes.
- H. UL 514 A - Metallic Outlet Boxes.
- I. UL 514 B - Fittings for Conduit and Outlet Boxes.

1.06 SUBMITTALS

- A. Product Data: Provide manufacturer's data for all items mentioned herein. Data must include information to determine conformance with specifications.
- B. Installation Instructions: For hazardous locations, submit manufacturer's written installation instructions.
- C. Shop drawings for nonstandard boxes, enclosures, and cabinets. Include layout drawings showing components and wiring.

1.07 PROJECT RECORD DOCUMENTS

- A. Submit accurate records of actual locations and mounting heights of outlet, pull, and junction boxes.
- B. Shop Drawings: Provide shop drawings for nonstandard boxes.

1.08 PROJECT CONDITIONS

- A. Contractor shall field verify that measurements are as shown on drawings.
- B. Electrical boxes are shown on drawings in approximate locations unless dimensioned. Install at location required for box to serve intended purpose. Not all boxes are shown on the plans, install boxes as required; refer to Section 26 05 33 - Raceway.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Hubbell Wiring Devices (Basis of Design)
- B. Thomas & Betts Corp.
- C. Carlon Electrical Products
- D. Walker Systems Inc.
- E. The Wiremold Co.
- F. Or equal as approved by the Professional

2.02 GENERAL

- A. Product Selection: Select boxes of types appropriate for each use and location:
 - 1. Select covers for boxes of types appropriate for each use and location.
 - 2. Provide gaskets for covers of boxes in damp or wet locations.
- B. Corrosion Resistance: Provide galvanized or other approved corrosion resistant finish for all boxes, accessories and fittings.

2.03 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.

- B. Interior Outlet Boxes: Provide minimum 4-inch (100 mm) square by 1-1/2 inch (38 mm) deep, one piece, deep-drawn, galvanized steel, outlet boxes for general use. 4-inch (100 mm) octagonal concrete boxes and hung ceiling boxes of the folded or welded type shall not be used unless specifically required by project conditions. Provide square cornered, straight sided gang boxes wherever required by NFPA 70 or more than two wiring devices are indicated in the same location. Boxes of increased depth shall be installed where required by field conditions.
 - 1. Construct with stamped knockouts in the back and sides.
 - 2. Provide threaded screw holes with corrosion-resistant screws for securing box covers and wiring devices.
 - 3. Other box sizes and shapes as required by manufacturer, field conditions, or as indicated on plans.
- C. Interior Outlet box Accessories: Provide outlet box accessories as required for each installation, including plaster covers, mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used and fulfilling requirements of individual wiring situations.
- D. Weatherproof Outlet Boxes: Provide corrosion-resistant cast-metal weatherproof outlet boxes, of types, shapes and sizes, including depth of boxes, with threaded conduit ends, cast-metal face plates and spring-hinged waterproof caps suitably configured for each application, including face plate gaskets and corrosion-resistant fasteners.
- E. All boxes for lighting outlets shall be provided with fixture studs of a size suitable for the weight of the fixture to be supported, but in no case less than 1/2". The stud shall be of integral construction with the box, or of the type which is inserted from the back of the box. In no case shall the weight of the fixture be dependent upon bolts holding the stud to the box.

2.04 PULL AND JUNCTION BOXES

- A. NEMA OS1.
- B. Junction and Pull Boxes: Provide galvanized sheet steel junction and pull boxes, with screw-on covers and of types, shapes and sizes, to suit each respective location and installation. Box shall be installed with stainless steel nuts, bolts, screws, washers, etc. Boxes shall be galvanized after fabrication.
 - 1. Provide welded seams and stainless steel nuts, bolts, screws and washers.
 - 2. Conform to the applicable requirements of NFPA 70 and to UL 50 for boxes over 100 cubic inches volume, except as modified below.
 - 3. Where necessary for boxes to provide a rigid assembly, provide integral structural steel bracing.
- C. Fiberglass Concrete composite Handholes: Die-molded, glass-fiber concrete composite hand holes:
 - 1. Cable Entrance: Pre-cut 6 inch x 6 inch cable entrance at center bottom of each side.
 - 2. Cover: Glass-fiber concrete composite, weatherproof cover with nonskid finish.

2.05 CONDUIT BODIES

- A. Provide galvanized cast-metal conduit bodies, of types, shapes and sizes, to suit respective locations and installation, construct with threaded-conduit-entrance ends, removable covers, and corrosion-resistant screws.

PART 3 - EXECUTION

1.01 INSTALLATION

- A. Install electrical boxes as shown on drawings, and as required for splices, taps, wire pulling, equipment connections, compliance with regulatory requirements, and manufacturer's written requirements.
- B. Provide boxes of adequate size to meet NFPA 70 volume requirements, but in no case smaller than sizes indicated.
- C. Install electrical boxes to maintain a neat mechanical appearance.
- D. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- E. Install boxes to preserve fire resistance rating of the building.
- F. Align adjacent wall-mounted outlet boxes for switches, thermostats, and similar devices with each other.
- G. Support and fasten boxes securely; Support boxes independently of conduit.
- H. Use gang box where more than one of the same device is mounted together. Do not use sectional box.
- I. NEMA Ratings:
 - 1. Outdoors: NEMA 3R
 - 2. Indoor: Dry - NEMA 1; Damp or Wet - NEMA 3R
- J. Use flush mounting boxes in finished areas.
- K. Do not install flush mounting boxes back-to-back; minimum 12 inch lateral separation. Install with minimum 24 inches separation in acoustic rated walls.
- L. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- M. Install stamped steel bridges to fasten flush mounting outlet box between studs.
- N. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- O. Install adjustable steel channel fasteners for hung ceiling outlet box.
- P. Do not fasten boxes to ceiling support wires or other piping systems.
- Q. Grounding: Provide each box to which a lighting fixture or receptacle is to be attached with a grounding terminal, consisting of either a green-colored washer-in-head machine screw, not smaller than No. 10-32, screwed into a tapped hole or a grounding bushing attached to one of the conduits.
- R. For outlet boxes for receptacles and switches mounted in desks or furniture cabinets or in glazed tile, concrete block, marble, brick, stone or wood walls, use rectangular shaped boxes with square corners and straight sides.
 - 1. Install boxes without plaster rings.
 - 2. Saw cut all recesses for outlet boxes in exposed masonry walls.

- S. Prohibited Work:
 - 1. Do not use sectional (gangable) boxes.
 - 2. Do not use device plates as covers for boxes in exposed location.
 - 3. Do not use round boxes where conduit must enter box through side of box, which would result in difficult and insecure connections when fastened with locknut or bushing on rounded surface.
 - 4. Back-to-back or through-wall boxes for outlets.
 - T. Protect outlet boxes to prevent entrance of plaster, and debris. Thoroughly clean foreign material from boxes before conductors are installed.
 - U. At the following locations use threaded hub type boxes with gasketed weatherproof covers:
 - 1. Exterior locations.
 - 2. Where installed on unfinished walls, columns or plasters. Cover gaskets may be omitted in dry locations.
 - 3. Where exposed to moisture laden atmosphere.
 - 4. Where indicated.
 - 5. Within 4' (1,200 mm) of steam connections.
 - V. Deep Boxes: Use extra deep concrete boxes maximum 6" (150 mm), where necessary to permit side conduit entrance without interfering with reinforcing.
 - W. Extension Rings: Where extension rings are required on existing outlet boxes, drill new mounting holes in the rings to align with the mounting holes on the existing boxes. More than one extension ring on an outlet box is not permitted.
 - X. Provide in each box, including boxes above switchboards and motor control centers, with sufficient clamps, grids, or devices to which cables are secured in neat and orderly fashion permitting ready identification and so that no cable will have an unsupported length of more than 30" (750 mm).
 - Y. When concealed in non-accessible walls or ceiling, mount pull boxes with the covers flush with the finished wall or ceiling.
 - Z. Junction boxes shall not be installed in non-accessible walls or ceiling spaces.
 - AA. Boxes shall not be abandoned in place.
 - BB. Telephone: Unless otherwise indicated provide pull and junction boxes for telephone, signal and other systems for which no wire is specified herein, at least 50 percent larger than would be required by Article 314 of NFPA 70. Locate boxes strategically and provide such shapes as to permit easy pulling of future wires or cables of types normally used in such systems.
- 1.02 INTERFACE WITH OTHER PRODUCTS
- A. Coordinate mounting heights and locations of outlets when they are assigned to specific equipment indicated on drawings.
 - B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation
- 1.03 ADJUSTING
- A. Adjust flush mounting outlets to make front flush with finished wall material.

B. Install knockout closure in unused box opening.

END OF SECTION 260532

SECTION 260533

RACEWAY

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 RELATED DOCUMENTS

- A. Applicable requirements of the drawings, Owner/ Contractor Agreement, General Conditions, Supplementary Conditions, Division 1 - General Requirements, and Unified Facilities Criteria Standards are part of this Section and have the same force and effect as if printed herein in full.

1.03 SECTION INCLUDES

- A. Electrical metallic tubing.
- B. Rigid metal conduit.
- C. Flexible metal conduit.
- D. Liquidtight flexible metal conduit.
- E. Rigid nonmetallic conduit.
- F. Metal Clad Cable
- G. Fittings and conduit bodies.

1.04 SUBMITTALS

- A. Product Data: Provide manufacturers standard documentation for all items. Data must include information required to determine conformance with specifications.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering Products that may be incorporated in the Work include, but are not limited to, the following:
 - 1. Allied Tube and Conduit (Basis of Design)
 - 2. Anamet Electrical, Inc.
 - 3. Electri-Flex Company
 - 4. O-Z/ Gedney
 - 5. Picoma Industries
 - 6. Republic Conduit

7. Robroy Industries
8. Southwire Company
9. Wheatland Tube Co
10. Arnco Corp
11. Hubbell, Inc.
12. CANTEX Inc.
13. Condux International
14. Appelton Electric Co.
15. Carlon
16. AFC Cable System
17. Or equal as approved by the Professional

2.02 CONDUIT REQUIREMENTS

- A. Minimum Size: 3/4 inch unless otherwise specified.
- B. Each electrical system, such as lighting (480/277V), receptacle (208/120V), emergency lighting, fire alarm system, telephone/data system, Building Automation System, security system, and CCTV system shall be routed in a dedicated conduit system.
- C. Underground Installations:
 1. Direct Burial Under Slab on Grade: Use schedule 40 PVC.
 2. Direct Burial Branch circuit wiring for lighting, pumps, receptacles, etc.: Use PVC conduit.
 3. Warning Tape: Provide warning tape to identify ductbank location at 12" below finished grade. Tape shall be 6" wide, detectable type, colored red with suitable warning legend.
- D. In slab, above grade:
 1. The installation of conduit in slab is prohibited unless specifically identified on plans or in specifications.
- E. Outdoor Locations, Above Grade: Use galvanized rigid steel conduit.
- F. Wet and Damp Locations: Use rigid steel conduit. All roof conduit penetrations shall use galvanized rigid steel conduit.
- G. Dry Locations:
 1. Exposed conduit in finished areas: Closely coordinate with Architect. Use of exposed raceway shall be kept to a minimum.
 2. Main incoming service: galvanized rigid steel conduit.
 3. Exposed conduit in non-finished areas not subject to damage: Use EMT with compression fittings.
 4. Exposed conduit in non-finished areas subject to damage: galvanized rigid steel conduit.
 5. Conduits in exterior walls: Rigid steel conduit.
 6. Conduit in Interior Walls: Electrical metallic tubing.
 7. Above False Ceiling: Electrical metallic tubing or MC cable with insulated ground conductor. Limit MC Cable to local whips from junction boxes to light fixtures and wiring devices.
 8. MC Cable is only allowable for branch circuits. MC Cable shall not be exposed in finished areas.
- H. Flexible Metal Conduit:
 1. Provide flexible conduits for connections to motors and other electrical equipment when it is subject to movement, vibration, misalignment, cramped quarters or where noise transmission is to be eliminated or reduced. Do not use flexible non-metallic conduit.

Flexible conduit shall be of the liquid-tight type when installed under any of the following conditions:

- a. Exterior locations.
- b. Moisture or humidity laden atmospheres where it is possible for condensation to accumulate.
- c. Corrosive atmospheres.
- d. Where water or spray due to wash-operations is frequent or possible.
- e. Wherever there is a possibility of seepage or dripping of oil, grease or water.
- f. Connections to pumps.
- g. Maximum allowable length is 6 foot.

2. Flexible metallic conduit (min. 1/2 inch trade size) shall be used for connection from junction boxes to lighting fixtures and similar equipment mounted in a suspended ceiling. Flexible metallic conduit shall be not less than 4' (1200 mm) nor more than 6' (1800 mm) in length to permit relocation flexibility. The flexible conduit shall connect the fixture to an accessible junction box above the suspended ceiling.

K. All other applications not specified herein, use rigid steel conduit.

L. The following cables are not permitted under any conditions: Romex cable, armored cable, or electrical nonmetallic tubing.

2.03 METAL CONDUIT

- A. Rigid Steel Conduit shall be hot dip galvanized conforming to FS WWC 581, ANSI C80.1 and UL 6. Fittings shall be threaded type of galvanized malleable iron construction.

2.04 FLEXIBLE METAL CONDUIT

- A. Flexible Metal Conduit shall be formed from continuous length of spirally wound, interlocked zinc-coated strip steel conforming to FS WWC 566 and UL 1. Fittings shall be of the threadless, hinged clamp type.

2.05 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Liquid-tight Flexible Metal Conduit shall be constructed of single strip, flexible, continuous, interlocked and double-wrapped steel, galvanized inside and outside and coated with liquid-tight jacket of flexible polyvinyl chloride (PVC). Fittings shall be liquid-tight compression type. Provide conduit with a continuous copper bonding conductor wound spirally between convolutions.

2.06 ELECTRICAL METALLIC TUBING (EMT)

- A. Electrical Metallic Tubing (EMT) shall be galvanized steel in accordance with FS WWC 563, ANSI C80.3 and UL 797. Fittings shall be compression type. All fittings shall be of wrought steel construction.

2.07 NONMETALLIC CONDUIT

- A. The nonmetallic conduit shall be in accordance with Fed. Spec. W-C-1094, Type II or Type III, UL 651 heavy wall PVC, NEMA TC2 and TC3 requirements.

2.08 METAL CLAD CABLE

- A. Metal-clad armor shall be galvanized steel. Conductors shall be in accordance with Section 26 05 19 and shall also include a separate insulated green grounding conductor. Cable for isolated

ground circuits shall include a separate insulated conductor; conductor shall be green with yellow stripe. Cable shall include a mylar tape assembly covering and conform to Federal Specification J-C-30B and UL83, H79, 1569, 1581.

- B. Type MC cable installation shall be in accordance with the following: No more than nine (9) total current-carrying conductors in multiple MC cable runs shall be bundled together into a single MC cable hanger. Wireway or ladder type tray with dual supports may also be used to support MC cable with fill as allowed by the NEC. Neutrals shall be counted as current-carrying conductors.
- C. MC cable shall be run parallel or perpendicular to walls. No diagonal runs shall be permitted.
- D. Maintain a clearance of at least 6 inches from hot water and other high temperature pipes and telecommunications conduits, and at least 12 inches from unshielded twisted-pair telecommunications cables.
- E. The arrangement of MC cables and fastening methods shall be subject to the approval of the Owner. Securely support all MC cable with cable hangers, individual spring steel support clips, steel trapeze hangers, threaded rods or dedicated No. 8 AWG drop wires. Cable supports shall be fastened to concrete slabs, beams, joists or other structural members of the building. Do not support MC cable on hung ceilings or on ceiling support wires. The use of cable ties to support MC cable is prohibited.
- F. Support MC cable every 3 feet and within 1 foot of every box, panelboard, fitting, or cable termination.
- G. All MC cables passing through fire-rated walls or electrical/telecommunications room walls shall be provided with a UL listed, fire-rated penetration assembly.

2.09 RACEWAY, FITTINGS, COUPLINGS, AND CONNECTORS

- A. Use fittings listed and approved for specific conduit or raceway system used.
- B. For threaded rigid steel conduit do not use threadless or compression type fittings.
- C. Fittings shall be steel or malleable iron. Die cast fittings shall not be used.
- D. Coupling and connectors on EMT shall be of the steel compression type. Die cast and set screw connectors shall not be used.
- E. Bushing and connectors shall be insulated type which maintain continuity of conduit grounding system. Insulating material shall be molded or locked into metallic body of the fitting. Bushing made entirely of nonmetallic material will not be allowed.
- F. Provide flexible metal conduit fittings made of steel or malleable iron. They shall be insulated and of the squeeze or clamp type having a bearing surface contoured to wrap around the conduit and clamped by one or more screws.
- G. Liquid-tight flexible metal conduit shall incorporate a threaded grounding cone, a steel, nylon or equivalent plastic compression ring and a gland for tightening. Fitting shall be steel, or malleable iron with insulated throat, with male thread and locknut or male bushing with or without "O" ring seal.
- H. Expansion fittings shall be hot-dipped galvanized malleable iron with a packing ring to prevent entrance of water, a pressure ring, a grounding ring and a separate external copper bonding jumper.

- I. Inferior material such as "pot metal" shall not be used for any type of fitting.
- J. All locknuts shall be the bonding type with sharp edges for digging into the metal wall of an enclosure.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. Install conduit in accordance with NECA "Standard of Installation."
2. Install nonmetallic conduit in accordance with manufacturer's instructions.
3. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
4. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
5. Cut conduit square using saw; de-burr cut ends.
6. Identify conduit under provisions of Section 260553.
7. Ground and bond conduit under provisions of Section 260526.
8. All metallic raceways shall be installed so that a continuous grounding path is maintained independent of the grounding conductor required in Section 260526.
9. In finished areas, conceal conduit and EMT within finished walls, ceilings, and floors unless indicated otherwise.
10. Make bends and offsets so the inside diameter is not effectively reduced. Changes in direction of conduit 1" and larger shall be made with standard elbows.
11. Unless otherwise indicated keep the legs of a bend in the same plane and the straight legs of offsets parallel.
12. Make bends in parallel or banked runs from the same center line so that the bends are parallel. Factory elbows may be used in banked runs where they can be installed parallel.
13. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.
14. Where chase nipples are used, align the raceway and coupling square to the box and tighten the chase nipple so no threads are exposed. Running threads are not allowed.
15. Horizontal cross runs of conduit or EMT shall not be installed in wall partitions or run through beams unless explicitly noted on plans.
16. Branch circuit conduits and raceways above suspended ceilings shall be supported from the floor construction; the finished installation shall not interfere with the removability of ceiling panels. Conduit shall not be supported from ceiling support wires.
17. Complete installation of electrical raceways before starting installation of cables/wires within raceways.
18. Prevent foreign matter from entering raceways; use temporary closure protection as required.
19. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, conduit hangers or clamp and clampback assemblies. One-hole straps may be used only for securing EMT. Support for conduit of each side of bend not to exceed the following spacing: up to 1" C: 6'-0"; larger than 1"C: 8'-0". Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.
20. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25 percent additional conduits.
21. Straps supporting conduits from beams shall be attached to beams by beam clamps.
22. Provide supports for raceways as specified in Section 260529. Electrical conduits shall not be supported on hangers with any other services, pipes, ducts or other mechanical systems and shall be supported independently of any ceiling support systems.
23. Level and square raceway runs.
24. Install horizontal raceway runs above water and steam piping.

25. Maintain 12 inch clearance between conduit and surfaces with temperatures exceeding 104 degrees F.
26. Arrange conduit to maintain headroom and present neat appearance.
27. All conduit, with the exception of underground or in-slab conduits, shall be routed parallel and perpendicular to nearby surfaces or exposed structural members and follow the surface contours.
28. Install no more than equivalent of three 90-degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams.
29. Junction and pull boxes shall be installed where necessary to facilitate the installation of raceway and pulling of wire and cable. The maximum length of straight conduit runs shall be 200 feet between pull boxes, with 50 feet deducted for each 90° bend and 25 feet deducted for each 45° bend. Reduction in length for all other angle bends shall be determined on a similar basis. For proper sizing of junction or pull boxes refer to Section 260532.
30. Provide locknuts on both sides of rigid conduit terminations in all junction boxes, panelboards and similar sheet metal enclosures.
31. Provide nylon insulated metallic bushings for terminating all rigid conduits. Bushings shall be installed before cables are pulled.
32. Use conduit hubs to fasten conduit to sheet metal boxes in damp and wet locations.
33. Bring conduit to shoulder of fittings; fasten securely.
34. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder.
35. Conduit and EMT runs shall be mechanically and electrically continuous from service entrance to all outlets. Each conduit shall enter and be securely connected to a cabinet, junction box, pull box or outlet by means of a locknut on the outside and a bushing on the inside.
36. Where the installation is such that joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system.
37. Lateral installations of conduit across rooftops exceeding eight feet in length is not acceptable.
38. Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts so that the dished part is against the box. Use two locknuts where circuit voltage exceeds 250 volts, one inside and the other outside the box, and where necessary to make the termination secure.
39. Provide suitable pull string in each empty conduit.
40. Provide sleeves for all conduits passing through hollow walls and concrete floors. Sleeves shall be installed in circular openings made by core drill or hole saw and shall be securely fastened. The annular space between the wall and the sleeve shall be kept to a minimum and filled with a fire retardant caulking compound. Sleeves shall be nominally 1 inch trade size larger and constructed of the same material as the conduit being installed. Sleeves thru floor shall extend 2" above and below slab in unfinished areas; flush with slab in finished spaces.

B. Expansion Fittings:

1. Provide suitable fittings to accommodate expansion and deflection where conduit crosses control or expansion joints. Fittings shall cross at right angles to joints.
2. Expansion fittings shall be located per NEC requirements and, as a minimum, at all building expansion joints.
3. Provide expansion fittings for all runs 1-1/2" or larger and exceeding 170' in length.

C. Public Address System, Security System, Intercom System, Clock System, and Fire Alarm System.

1. All system wires shall be installed in conduit. Power wiring shall not be installed in the same conduit.
2. Fire alarm system wires shall be installed in a dedicated conduit.

D. Raceways in Concrete

1. In slabs and walls, locate raceways in middle third and leave at least 1" (25 mm) concrete cover. The outside raceway diameter shall not exceed 1/3 of the slab or wall thickness. Lateral spacing of raceways shall be not less than three diameters except where drawings definitely indicate that the concrete slab has been especially designed to accommodate a closer spacing of conduits entering wire closets, panelboards, or electrical boxes or the arrangement is approved.
2. Where nonmetallic conduit is used, convert to rigid steel 5'-0" (horizontal distance) before rising above or turning below floor. Provide ground continuity.
3. Tie raceway to reinforcing rods or support to prevent sagging or disturbing when concrete is placed.
4. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab, nor below the slab where the slab is a finished ceiling.
5. Provide conduits stubbed up through or from concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs, set flush with the finished floor. Extend conductors to equipment in rigid steel conduit, except that flexible metal conduit may be used 6" (150 mm) above the floor. Where no equipment connections are made, install screwdriver-operated threaded flush brass plugs in conduit end.

E. Raceway Sealing Fittings:

1. Sealing fittings for use with threaded steel conduits shall be of the threaded, zinc or cadmium coated, cast or malleable iron type and sealing fittings for use on aluminum conduit shall be of the threaded cast aluminum type. Fittings used to prevent passage of water vapor shall be of the continuous drain type.
2. In concealed work, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.
3. Provide raceway sealing fittings at the following points, and elsewhere as indicated:
 - a. Where conduits penetrate the roof. Install on roof in close proximity to roof penetration. Provide conduit drain before seal.
 - b. Where conduits pass from exterior to interior locations.
 - c. Where conduits enter or leave hazardous areas equipped with explosion-proof lighting fixtures, switches, or receptacles.
 - d. Where conduits pass from warm locations to cold locations, such as refrigerated spaces and air-conditioned spaces.
 - e. Where conduit enters building from below grade. Additionally, provide a brass or stainless-steel conduit drain between seal and exterior wall where seal is below grade.
 - f. Where required by the NFPA 70.

3.02 INTERFACE WITH OTHER PRODUCTS

- A. Install conduit to preserve fire resistance rating of partitions and other elements.
- B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation specified.
- C. Upon completion of installation of raceways, inspect interiors of raceways at all outlet, junction and pull boxes, remove burrs and obstructions.
- D. Run a swab or mandrel to remove dirt and blockages for conduits 2" or larger. Raceways which are deformed and prevent the passage of a mandrel shall be replaced.

END OF SECTION 260533

SECTION 260553
ELECTRICAL IDENTIFICATION

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. Applicable requirements of the Drawing, Owner/ Contractor Agreement, General Conditions of Contract for Construction, Unified Facilities Criteria Standards, Supplementary Conditions, and Division 1 - General Requirements, are part of this Section and have the same force and effect as if printed here in full.

1.3 SECTION INCLUDES

- A. This Section includes identification of electrical materials, equipment, and installations. The electrical identification components including but not limited to the following:
 - 1. Nameplates.
 - 2. Buried electrical line warnings.
 - 3. Identification labeling for cables, pull boxes, junction boxes and conductors.
 - 4. Warning and caution signs.
 - 5. Equipment labels and signs.
 - 6. Wire markers.
 - 7. Lockout Devices.
 - 8. Stencils.
- B. Refer to individual Division 26 sections for additional electrical identification requirements.

1.4 SUBMITTALS

- A. Product Data for each type of product specified.
- B. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.

1.5 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code.
- B. UL 969 - Underwriters Laboratories.
- C. FS L-P-387 - Federal Specifications.
- D. ANSI A13.1- American National Standards Institute.

1.6 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code".
- B. ANSI Compliance: Comply with requirements of ANSI Standard A13.1, "Scheme for the Identification of Piping Systems," with regard to type and size of lettering for raceway and cable labels.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. American Labelmark Co. (Basis of Design)
 - 2. Calpico, Inc.
 - 3. Cole-Flex Corp.
 - 4. Emed Co., Inc.
 - 5. George-Ingraham Corp.
 - 6. Ideal Industries, Inc.
 - 7. Kraftbilt
 - 8. LEM Products, Inc.
 - 9. Markal Corp.
 - 10. National Band and Tag Co.
 - 11. Pundit Corp.
 - 12. Radar Engineers Div., EPIC Corp.
 - 13. Seton Name Plate Co.
 - 14. Standard Signs, Inc.
 - 15. Brady, Co.
 - 16. Or equal as approved by the Professional

2.02 ELECTRICAL IDENTIFICATION PRODUCTS

- A. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter. Such identification shall include circuit/circuit breaker number, conductor gauge and destination (at source location) or source (at destination and intermediate locations).
- B. Plasticized Card Stock Tags: Provide phenolic or laminated plastic tags with machine printed legend to suit the application. Provide black legend on orange background, except as otherwise indicated and eyelet for faster. Tags shall identify circuit/circuit breaker number, conductor gauge, and destination (at source location) or source (at destination or intermediate locations.).
- C. Engraved Plastic-Laminate Labels, Signs and Instruction Plates: Provide engraving stock melamine plastic laminate, 1/8-inch minimum thickness. Engrave legend in white letters on black face and punch for mechanical fasteners.
- D. Baked Enamel Warning and Caution Signs: Provide re-printed aluminum signs suitable for indoor use with colors and legend appropriate to the location, punched for fasteners, and sized for good visibility.

- E. Metal Backed Butyrate Warning and Caution Signs: Provide weather resistant, non-fading pre-printed cellulose acetate butyrate signs with 20 gauge galvanized steel backing, with colors and legend appropriate to the location, and size selected for good visibility. Provide 1/4-inch grommets in corners for mounting.
- F. Nameplates: Engraved three-layer laminated plastic, black letters on white background.
 - 1. Embossed tape will not be permitted for any application.
- G. Fasteners for Plastic Laminate and Metal Signs: Provide self tapping stainless steel screws or No. 10/32 minimum stainless steel machine screws with nuts, and flat and lock washers.
- H. Cable Ties: Provide fungus-inert, self-extinguishing, one piece, self locking nylon cable ties 0.18 inch minimum width. 50 pounds minimum tensile strength and suitable for a temperature range from -50 degrees F. to +350 degrees F°. Provide ties in specified colors when used for color coding.
- I. Underground Warning Tape: Provide 4 inch wide plastic tape, detectable type, colored red with suitable warning legend describing buried electrical lines.
- J. Service equipment shall be marked with maximum available fault current including date the fault current calculation was performed per NEC 110.24. When modifications to the electrical installation affect the maximum available fault current at the service, the fault current must be recalculated and relabeled.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code.
- B. Degrease and clean surfaces to receive adhesive for identification materials.
- C. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.
- D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
- E. Identify Junction, Pull, and Connection Boxes: Code-required caution sign for boxes shall be pressure-sensitive, self-adhesive label indicating system voltage in black, preprinted on orange background. Install on outside of box cover. Also label box covers with identity of contained circuits. Use pressure-sensitive plastic labels at exposed locations and similar labels or plasticized card stock tags at concealed boxes.
- F. Tags or label conductors as follows:
 - 1. Multiple Circuits: Where multiple branch circuits or control wiring or communications/signal conductors are present in the same box or enclosure (except for three-circuit, four-wire home runs), label each conductor or cable. Provide legend indicating source, voltage, circuit number, and phase for branch circuit wiring. Phase and voltage of branch circuit wiring may be indicated by means of coded color of conductor insulation. For control and communications/signal wiring, use color coding or wire/cable marking tape at terminations

and at intermediate locations where conductors appear in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.

2. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.
3. Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junctions boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits, and with control wire number as indicated on schematic and interconnection diagrams of equipment manufactures shop drawings for control wiring.

G. Install equipment/system circuit/device identification nameplates as follows:

1. Apply equipment nameplates of engraved plastic-laminate (black with white letters) on each major unit of electrical equipment in building, including central or master unit of each electrical system. This includes communication/signal/alarm systems, unless unit is specified with its own self-explanatory identification. Provide text, with 1/4-inch-high lettering on each nameplate. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply nameplates for each unit of the following categories of electrical equipment.
 - a. Panelboards, electrical cabinets, and enclosures: Identify type, designation and source of power.
 - b. Electrical switchgear and switchboards: Identify type, designation and source of power. Also identify each feeder breaker, "Service Disconnect" shall be identified as applicable.
 - c. Motor starters: Identify load served and circuit number.
 - d. Control devices: Identify load served.
 - e. Fire alarm master station or control panel: Identify panel and circuit number.
2. Apply equipment nameplates of engraved plastic-laminate (black with white letters) on each wiring device in the building as identified below. Provide a text, with 1/8-inch-high lettering on each nameplate. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply nameplates for each unit of the following categories of electrical equipment:
 - a. Power outlets, thermal overload switches, receptacles and switches dedicated to specific equipment: Identify panel and circuit number.
3. Attach nameplates with pop rivets or screws.
 - a. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

H. Warning, Caution and Instruction Signs and Stencils:

1. Where required by NFPA 70, where indicated on drawings or specified, or wherever reasonably required to ensure safe operation and maintenance of electrical systems and of the items to which they connect, install warning, caution or instruction signs. Where instructions or explanations are needed for system or equipment operation, provide engraved plastic laminate instruction signs with approved legend. For outdoor items provide butyrate signs with metal backing.
- I. Provide approved tags for all feeders (600V and less), at both ends and at all intermediate junction and pull boxes. Tag shall indicate the feeder designation or equipment served, panel name and circuit number (or other source of feeder), and shall state voltage, phase, and amperes of circuit. Provide feeder tags with wording and layout similar to lexan nameplates indicated above.
- J. Install underground warning tape along length of each underground conduit, raceway, or cable 12 inches below finished grade, directly above buried conduit, raceway, or cable.

- K. All receptacle cover plates, including laboratory multi-outlet raceway receptacles, shall be identified as to panel and circuit number; this information shall be identified by means of a printed self-adhesive label. Label shall be translucent or clear polyester with black lettering, waterproof, and scratchproof.

END OF SECTION 260553

SECTION 260573
POWER SYSTEM STUDY

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 RELATED DOCUMENTS

- A. Applicable requirements of the Drawings, Owner/ Contractor Agreement, General Conditions, Supplementary Conditions, Division 1 - General Requirements, and Unified Facilities Criteria Standards are part of this Section and have the same force and effect as if printed herein in full.

1.03 SECTION INCLUDES

- A. Complete Short Circuit and Protective Device Coordination Study to meet requirements of NFPA 70.
- B. The contractor shall have a short circuit and coordination study prepared for the electrical overcurrent devices to be installed under this project to assure proper equipment and personnel protection.
- C. The study shall present an organized time-current analysis of each protective device in series from the individual feeder protective devices back to the source. The study shall reflect the operation of each device during normal and abnormal current conditions.
- D. The contractor shall have the coordination study prepared by the qualified engineers. Study shall be stamped by a professional engineer registered in the state of Pennsylvania. The contractor is responsible for providing all pertinent information required by the preparers to complete the study.
- E. The study shall include the existing equipment, fusing, and relaying installed including 225kVA transformer primary fuses, 4160V feeder circuit breaker for 225kVA transformer, main 4160V circuit breaker, and main 35kV fuses.
- F. The study shall include existing incoming line Utility relay settings.
- G. The contractor shall also perform the following studies:
 - 1. Provide an Arc Flash Hazard Study for the electrical distribution system. The intent of the Arc Flash Hazard Study is to determine hazards that exist at each major piece of electrical equipment. The study will include creation of Arc Flash Hazard Warning Labels. These labels serve as a guide to assist technicians and others in the selection of proper Personal Protective Equipment when working around exposed and energized conductors. The electrical contractor will install the labels.

1.04 REFERENCES

- A. Institute of Electrical and Electronics Engineers:
 - 1. IEEE 242 - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (Buff Book).
- B. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code.

1.05 SUBMITTALS

- A. In accordance with general section of the specifications, furnish the following:
 - 1. Submit protective equipment shop drawings simultaneously with the protective device study.
 - 2. The studies shall be submitted to the Design Engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment for manufacturing.
 - 3. Any assumptions made in the study shall be clearly identified.
 - 4. Certification: Upon notification from the contractor that the settings have been set per the study, the Manufacturers shall visit the site and certify the installation. Deliver four copies of the following certifications:
 - a. Certification by the Manufacturer that the protective devices have been adjusted and set in accordance with the approved protective device study.
 - 5. Provide on disk a copy of the settings as well as the software that may be used to set devices.
 - 6. Submit an electronic copy of the final study in the format used to perform the study. Convert and submit in SKM format also.

1.06 REQUIREMENTS

- A. Complete Short Circuit and Protective Device Coordination Study to meet requirements of NFPA 70.
- B. The studies shall include all portions of the electrical distribution system from the normal power source or sources down to and including the smallest adjustable trip circuit breaker in the distribution system. Normal system connections and those which result in maximum fault conditions shall be adequately covered in the study. This includes all distribution equipment that will be part of the building (branch circuit panelboards).
- C. The complete study shall include a system one line diagram, short circuit and ground fault analysis, and protective coordination plots.
- D. Submit an electronic copy of the final study in the format used to perform the study. Convert and submit in SKM format also
- E. Study shall be complete prior to submittal of electrical equipment. Electrical equipment associated with the study will not be reviewed until submission of the study.
- F. One Line Diagram:
 - 1. Show, on the diagram, all electrical equipment and wiring to be protected by the overcurrent devices installed under this project. Clearly shown, on the one line, the schematic wiring of the electrical distribution system.
 - 2. Also show on the one line diagram the following specific information:
 - a. Calculated fault impedance, X/R ratios, and short circuit values at each bus.

- b. Breaker and fuse ratings.
- c. Transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.
- d. Voltage at each bus.
- e. Identification of each bus.
- f. Conduit material, feeder sizes, length, and X/R ratios.

1.07 DATA COLLECTION FOR THE STUDY

- A. The contractor and manufacturer shall provide the required data for preparation of the studies. The contractor and manufacturer shall furnish the Engineer with a listing of the required data immediately after award of the contract and shall coordinate any assumptions prior to submitting study.

1.08 SHORT-CIRCUIT STUDY

- A. The short-circuit study shall be performed with the aid of a digital computer program and shall be in accordance with the latest applicable IEEE and ANSI standards.
- B. In the short-circuit study, provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, typical calculations, tabulations of calculation quantities and results, conclusions, and recommendations. Calculate short-circuit interrupting and momentary duties for an assumed 3-phase bolted fault at each supply switchgear lineup, unit substation primary and secondary terminals, low-voltage switchgear lineup, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboard, and other significant overcurrent protective device locations throughout the system. Provide a ground fault current study for the same system areas, including the associated zero sequence impedance data. Include in tabulations fault impedance X to R ratios, asymmetry factors, motor fault contribution, short circuit kVA, and symmetrical and asymmetrical fault currents.
- C. Present the data determined by the short circuit study in a table format. Include the following:
 - 1. Device identification.
 - 2. Operating voltage.
 - 3. Protective device.
 - 4. Device rating.
 - 5. Calculated short circuit current.

1.09 COORDINATION STUDY

- A. In the protective device coordination study, provide time-current curves graphically indicating the coordination proposed for the system centered on conventional, full-size, log-log forms. Include with each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered by that particular curve sheet. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings.
- B. Include on the curve sheets power company relay and fuse characteristics, medium-voltage equipment protective relay and fuse characteristics, low-voltage equipment circuit breaker trip device characteristics, pertinent transformer characteristics, pertinent motor and generator characteristics, and characteristics of other system load protective devices. In addition, include

all devices down to the largest branch circuit and largest feeder circuit breaker in each motor control center, and main breaker in branch panelboards.

- C. Include all adjustable settings for ground fault protective devices. Include manufacturing tolerance and damage bands in plotted fuse characteristics. Show transformer full load currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and significant symmetrical fault currents. Terminate device characteristic curves at a point reflecting the maximum symmetrical fault current to which the device is exposed.
- D. The following specific information shall also be shown on the coordination curves:
 - 1. Device identification.
 - 2. Voltage and current ratio for curves.
 - 3. 3-phase and 1-phase ANSI damage points for each transformer.
 - 4. No-damage, melting, and clearing curves for fuses.
 - 5. Cable damage curves.
 - 6. Transformer inrush points.
 - 7. Maximum short circuit cutoff point.
 - 8. Relay types and settings.
- E. Develop a table to summarize the settings selected for the protective devices. Include in the table the following:
 - 1. Device identification.
 - 2. Relay CT ratios, tap, time dial, and instantaneous pickup.
 - 3. Fuse rating and type.
 - 4. Ground fault pickup and time delay.
 - 5. Differential protection relay settings.
 - 6. Undervoltage protection relay settings.
 - 7. Automatic transfer schemes operation and relaying, including proposed time delays between different voltage levels and different steps.

1.10 ARC FLASH HAZARD STUDY

- A. Perform an arc flash hazard study after the short circuit and protective device coordination study has been completed.
- B. The study shall be calculated by means of a Windows computer software package. Pertinent data, rationale employed, and assumptions in developing the calculations shall be incorporated in the introductory remarks of the study.
- C. The study shall be in accordance with applicable NFPA 70E, OSHA 29-CFR, Part 1910 Sub part S and IEEE 1584 Standards.
- D. Determine the following:
 - 1. Flash Hazard Protection Boundary
 - 2. Limited Approach Boundary
 - 3. Restricted Boundary
 - 4. Prohibited Boundary
 - 5. Incident Energy Level
 - 6. Required Personal Protective Equipment Class
 - 7. Type of Fire Rated Clothing

- E. Produce an Arc Flash Warning label listing items 1 – 7 above. Also include the bus name, system operating voltage, and date of issue. Labels shall be printed in color and be printed on adhesive backed Avery Labels.

- F. Produce Bus Detail sheets that lists the items D 1-7 from above and the following additional items:
 - 1. Bus Name
 - 2. Upstream Protective Device Name, Type, and Settings
 - 3. Bus Line to Line Voltage

- G. Produce Arc Flash Evaluation Summary Sheet listing the following additional items:
 - 1. Bus Name
 - 2. Upstream Protective Device Name, Type, and Settings
 - 3. Bus Line to Line Voltage
 - 4. Bus Bolted Fault
 - 5. Protective Device Bolted Fault Current
 - 6. Arcing Fault Current
 - 7. Protective Device Trip / Delay Time
 - 8. Breaker Opening Time
 - 9. Solidly Grounded Column
 - 10. Equipment Type
 - 11. Gap
 - 12. Arc Flash Boundary
 - 13. Working Distance
 - 14. Incident Energy
 - 15. Required Protective Fire Rated Clothing Type and Class

1.11 ANALYSIS

- A. Analyze the studies, and highlight any equipment that is determined to be underrated as specified. Propose approaches to effectively protect the underrated equipment. Proposed major corrective modifications will be taken under advisement by the Engineer, and the Contractor will be given further instructions.
 - 1. Provide minor modifications to conform with the study (Examples of minor modifications are trip sizes within the same frame, the time curve characteristics of relays, C.T. ranges, etc.).

- B. After developing the coordination curves, highlight areas lacking coordination. Present a technical evaluation with a discussion of the logical compromises for best coordination.

Part 2 - PRODUCTS

Not used.

PART 1 - EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Provide assistance to electrical distribution system equipment manufacturer during start up of electrical system and equipment.

- B. Select each primary protective device for delta-wye connected transformer so device's characteristic or operating band is within transformer characteristics, including point equal to 58 percent of ANSI withstand point to provide secondary line-to-ground fault protection.
- C. Separate transformer primary protective device characteristic curves from associated secondary device characteristics by 16 percent current margin to provide proper coordination and protection in event of secondary line-to-line faults.
- D. Separate medium-voltage relay characteristic curves from curves for other devices by at least 0.4 second time margin.

END OF SECTION 260573

SECTION 262416
PANELBOARDS

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 RELATED DOCUMENTS

- A. Applicable requirements of the Drawings, Owner/Contractor Agreement, General Conditions, Unified Facilities Criteria Standards, Supplementary Conditions, and Division 1 - General Requirements, are part of this Section and have the same force and effect as if printed herein in full.

1.03 WORK INCLUDED

- A. Lighting and appliance panelboards.
- B. Power distribution panelboards

1.04 RELATED WORK

- A. Section 26 05 29.

1.05 REFERENCES

- A. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
- B. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
- C. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
- D. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- E. NEMA PB 1 - Panelboards.
- F. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- G. UL 50, 67, 1283 and 1449 - Underwriters Laboratories.
- H. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

1.06 SUBMITTALS

- A. Submit shop drawings for equipment and component devices, include layout and single line diagram.
- B. Submittal shall also include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.
- C. Power system protection coordination study. The study must be submitted before or with the panelboard submittal. The panelboard submittal will not be reviewed without the study.
- D. Obtain and review shop drawings, product data, and manufacturer's instructions for all furnished equipment, including equipment furnished under other divisions, prior to ordering panelboards. Modify circuit breakers in panelboards as necessary to accommodate furnished equipment.

1.07 SPARE PARTS

- A. Keys: Furnish 2 spares for each panelboard cabinet lock.
- B. Touch-up paint for surface mounted panelboards: One half pint container.

1.08 PROJECT RECORD DOCUMENTS

- A. Identify actual panelboard locations.

1.08 WARRANTY

- A. The manufacturer shall warrant products against defects in material and workmanship for 24 months from date of field installation, contractor field testing and manufacturers field acceptance. During the warranty period the manufacturer shall repair or replace defective products. This warranty shall be in addition to any provided by the Contractor. The warranty shall exclude normal wear and tear under normal usage and any damage caused by abuse, modification, or improper maintenance by entities other than the manufacturer or its approved representative.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Panelboards shall be installed as specified herein.
- B. Acceptable manufacturers contingent upon compliance with the requirements as shown on the plans and specified herein.
 - 1. Eaton (Basis of Design)
 - 2. Siemens Energy and Automation Inc.
 - 3. Square D Co.
 - 4. Or equal as approved by the Professional

2.02 PANELBOARDS

- A. Panelboards: NEMA PB 1; circuit breaker type FS W-P-115.
- B. Series Rated circuit breakers are not permitted.

- C. Provide factory assembled dead front cabinet front with concealed trim clamps, screw cover, and concealed hinged door with flush lock. Finish in manufacturer's standard gray enamel.
- D. Main and Neutral lugs: Compression type.
- E. Bus: 98% conductive rectangular copper bus, ratings as scheduled on drawings. Provide copper ground bus in all panelboards.
- F. Special Features: Provide the following features for panelboards:
 - 1. All breakers shall be of the bolt-on type.
 - 2. Provide isolated ground bus in all panelboards connected to isolated ground receptacles and as indicated on schedules. Bus shall be insulated from box.
- G. All lugs on panelboards and circuit breakers shall be rated 75C.
- H. Minimum short circuit rating as shown on drawings.
- I. Molded Case Circuit Breakers: NEMA AB 1 FS W-C-375; provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Circuit breakers shall have their ampere trip rating clearly marked and visible. Furnish circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits and listed as Type SWD for lighting circuits.
- J. The bus assembly shall consist of copper bus structure, securely fastened to rigid galvanized mounting pan and arranged to receive breakers as indicated. All bussing shall be designed in accordance with UL standards to suit the loading requirements as scheduled and shall be braced to withstand mechanical stresses created by faults of magnitude equivalent to the rating of breakers to be installed. Bus arrangement shall be sequence phased such that adjacent single pole breakers shall be connected to opposite phases in such a manner as to allow two and three pole breakers to be installed in any location. Bus assembly shall include main lugs and main breakers where specified. Arrangement shall also include double row construction of breakers and allowance for breaker replacement from the front without disturbing adjacent units or main bus connections. Bus and mounting pan shall be designed so that circuit breakers may be changed or added without additional machining, drilling or tapping. Bus supports shall be properly insulated. Construction shall be such that the bus will not be exposed upon removal of trim.
- K. Circuit breakers shall be of the quick-make, quick-break, trip free, bolt-on, thermal magnetic type with characteristics as scheduled. Automatic tripping shall be clearly indicated by the operating handle assuming a mid-position between ON and OFF. All two and three pole breakers shall have common trip. Branch circuit breakers shall be fully interchangeable without disturbing adjacent units. Breakers utilized in panelboards rated above 250 volts shall have phase identification markings, clearly indicated on the breaker. The marking shall indicate to which phase the breaker is connected and shall be located near the breaker terminals and not on any removable parts of the panelboards. All lighting branch circuit breakers shall be switch rated. All breakers feeding HID lighting circuits and fluorescent lighting circuits shall be rated for such loads. All breakers for air conditioning and refrigeration equipment shall be UL listed as HACR. Use of single pole breakers with handle ties or bails in lieu of multiple breakers is unacceptable.
- L. Door-in-door trim shall be provided. Two milled type keys shall be provided with each panel. Trim shall be equipped with a neat directory frame secured to the inside of the door. Trim shall be properly cleaned and finished with one rust-inhibiting priming coat and a finish coat of light gray enamel. All circuits shall be identified as specified hereinafter.
- M. All panelboards shall be provided with solid neutrals, where required. In addition, grounding bars with lugs shall be provided on all panelboards, meeting UL and NEMA standards. Other special features shall be provided as required and indicated.

- N. Special-Use Markings: Provide panelboards, constructed for special-use, with appropriate UL markings which indicate that they are suitable for special type of use/application. For example, panelboard with main breaker functioning as service disconnecting means shall be UL listed service entrance.
- O. Provision for Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances, for the OCPD ampere ratings indicated for future installation of devices.
- P. Nameplate: Nameplates shall be provided for all panelboards, refer to section 26 05 53.
- Q. Provide Surge protective Devices as indicated on drawings per Section 26 35 53.

2.03 SERVICE ENTRANCE PANELBOARDS

- A. Ground-fault protection of equipment shall be provided for solidly grounded wye electrical services of more than 150 volts to ground, but not exceeding 600 volts phase-to-phase for each service disconnect rated 1000 amperes or more.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General: Install panelboards and accessory items in accordance with NEMA PB 1.1, "General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less" and manufacturers' written installation instructions.
- B. Ground Fault Protection: Install panelboard ground fault circuit interrupter devices in accordance with installation guidelines of NEMA 289, "Application Guide for Ground Fault Circuit Interrupters."
- C. Mounting Heights: Top of trim 6 feet above finished floor, except as indicated. install panelboards taller than 6 feet with bottom no more than 4 inches above floor.
- D. Mounting: Plumb and rigid without distortion of box. Mount flush panels uniformly flush with wall finish.
- E. Circuit Directory: Typed and reflective of final circuit changes required to balance panel loads. Obtain approval before installing.
- F. Install filler plates in unused spaces.
- G. Provision for Future Circuits at Flush Panelboards: Stub four 1-inch empty conduits from panel into accessible ceiling space or space designated to be ceiling space in future. Stub four 1-inch empty conduits below slab other than slabs on grade.
- H. Wiring and Panel Gutters: Train conductors neatly in groups, bundle, and wrap with wire ties after completion of load balancing.

3.02 IDENTIFICATION

- A. Identify field-installed wiring and components and provide warning signs in accordance with Section 26 05 53.

3.03 GROUNDING

- A. Ground equipment to main electrical ground.

3.04 CONNECTIONS

- A. Tighten electrical connectors and terminals, including grounding connections, in accordance with manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.05 FIELD QUALITY CONTROL

- A. Pretesting: Upon completing installation of the system, perform the following preparations for independent tests:
 - 1. Make insulation resistance tests of panelboard buses, components, and connecting supply, feeder, and control circuits.
 - 2. Make continuity tests of circuits.
 - 3. Provide set of Contract Documents to test organization. Include full updating on final system configuration and parameters where supplement or differ from those indicated in original Contract Documents.
- B. Quality Control Program: Conform to the following:
 - 1. Procedures: Make field tests and inspections and prepare panelboard for satisfactory operation in accordance with manufacturer's recommendations and these specifications.
 - 2. Provide at least one weeks advance notification of scheduled tests.
 - 3. Reports: Provide written reports of tests and observations. Report defective materials and workmanship and unsatisfactory test results. Include records of repairs and adjustments made.
 - 4. Labeling: Upon satisfactory completion of tests and related effort, apply a label to tested components indicating results of tests and inspections, responsible organization and person, and date.
 - 5. Protective Device Ratings and Settings: Verify indicated ratings and settings to be appropriate for final system configuration and parameters. Where discrepancies are found, recommend final protective device ratings and settings. Use accepted ratings or settings to make the final system adjustments.
- C. Visual and Mechanical Inspection: Include the following inspections and related work:
 - 1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.
 - 2. Exercise and perform operational tests of all mechanical components and other operable devices in accordance with manufacturer's instruction manual.
 - 3. Check panelboard mounting, area clearances, and alignment and fit of components.
 - 4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
- D. Electrical Tests: Perform in accordance with manufacturer's instruction and with the latest edition of the International Electrical Testing Association (NETA) specification and including but not limited to the following:
 - 1. Insulation resistance test of buses and portions of control wiring that are disconnected from solid-state devices. Insulation resistance less than 100 megohms is not acceptable.
 - 2. Ground resistance test on system and equipment ground connections.

- E. Retest: Correct deficiencies identified by tests and observations and provide retesting of panelboards by testing organization. Verify by the system tests that the total assembly meets specified requirements.

3.06 CLEANING

- A. Upon completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

3.07 POWER SYSTEM PROTECTION COORDINATION STUDY

- A. A power system coordination study shall be performed and furnished for each station. The single-line contract drawing shows only the basic layout necessary to accomplish the required protection schemes. Provide a system fully coordinated. The devices specified are shown for information only and is not intended to limit the selection of protective devices to those listed. A complete protection and coordination study shall be prepared and included on shop drawings, or in the study, to denote actual protective items of equipment proposed and approved to accomplish the required degree of coordination between protective devices within and external to the switchboards and panelboards. The study shall provide the time-current characteristic curves or data of protective devices set by the Utility Company, the main Stations which are needed by the Contractor to make a complete coordination study. The Contractor shall submit time-current characteristic curves, all calculations, and manufacturer's data required to demonstrate proof of compliance with these requirements.

END OF SECTION 262416

SECTION 262726
WIRING DEVICES

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 RELATED DOCUMENTS

- A. Applicable requirements of the Drawings, Owner/Contractor Agreement, General Conditions, Supplementary Conditions, Unified Facilities Criteria Standards, and Division 1 - General Requirements, are part of this Section and have the same force and effect as if printed herein in full.

1.03 SECTION INCLUDES

- A. Wall Switches.
- B. Receptacles - General.
- C. Receptacles – Ground Fault Circuit Interrupting.
- D. Twist Lock Devices.
- E. Receptacles – Weatherproof.
- F. Lighting Control.
- G. Wall Plates.

1.04 RELATED SECTIONS

- A. Section 260532 - Boxes.
- B. Section 260533 - Raceway.
- C. Section 260519.
- D. Section 260526 - Grounding.
- E. Section 260553 – Identification.

1.05 REFERENCES

- A. NFPA 70 - National Electrical Code.
- B. UL5 - Raceways and Fittings, Electrical Surface Metal.
- C. UL20 - General-Use Snap Switches.

- D. UL 231 - Power Outlets, Electrical.
 - E. UL 467 - Grounding and Bonding Equipment, Electrical.
 - F. UL 498 - Attachment Plugs and Receptacles, Electrical.
 - G. UL 508 – Motor Starter Switches.
 - H. UL 514 - Outlet Boxes and Fittings, Electrical.
 - I. UL 943 - Ground Fault Circuit Interrupters.
 - J. UL 1010 - Receptacle - Plug Combinations, Electrical, For Use In Hazardous Locations.
 - K. UL 1054 - Switches, Special Use.
 - L. UL 88C1, 2709 – Motion Switching Sensors.
 - M. NEMA WD1 - General Purpose Wiring Devices.
 - N. NEMA WD3 - A/C General-Use Snap Switches.
 - O. NEMA WD5 - Specific - Purpose Wiring Devices.
 - P. NEMA WD 6 - Wiring Devices-Dimensional Requirements.
 - Q. ANSI C73 - Attachment Plugs and Receptacles, Dimension of.
- 1.06 SUBMITTALS
- A. Product Data: Provide manufacturer's catalog information indicating dimensions, colors, ratings, material, grade, and additional information in order to determine compliance with drawing and specifications for each type of device, device plates and box covers.
 - B. Samples: Provide samples of specified devices upon request.
- 1.07 COORDINATION
- A. Wiring Devices for Equipment Furnished by Owner or by other Contractors: Match devices to plug connectors.
 - B. Cord and Plug Sets: Match cord and plug sets to equipment requirements.
- 1.08 OPERATION AND MAINTENANCE MANUALS
- A. Technical data sheets, maintenance data, and information for ordering replacement units.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. All devices shall be the product of a single manufacturer unless otherwise noted.

2.02 WALL SWITCHES

A. Manufacturers:

1. Hubbell HBL1221. (Basis of Design)
2. Cooper
3. Pass and Seymour
4. Or equal as approved by the Professional

B. Description:

1. NEMA WD 1, heavy duty industrial grade AC only, high-abuse quiet switch. Rocker type switches shall not be installed. UL listed under 20. Back and side wired, fully enclosed in composition case. Terminals on contacts shall be brass and accommodate up to #10 solid wire.

C. Device Body: Plastic with toggle handle except as indicated or required by code. Coordinate color with Architect.

D. Voltage Rating: 120 – 277 VAC.

E. Current Rating: 20 amperes.

2.03 RECEPTACLES

A. Manufacturers:

1. Hubbell 5362. (Basis of Design)
2. Cooper
3. Pass and Seymour
4. Or equal as approved by the Professional

B. Description: NEMA WD 1; heavy-duty specification grade general-use receptacle. UL listed under 498. Receptacles shall be back and side wired, provide green ground screw terminal automatic ground clamp, fully enclosed in composition case, nylon face, and have brass wrap around bridge for installation strength.

C. Device Body: Plastic except as indicated or required by Code. Non-controlled receptacles and controlled receptacles shall be different colors. Coordinate color with Architect.

D. Configuration: NEMA WD 6; type as specified and indicated.

E. Convenience Receptacle: NEMA Type 5-20R.

F. Optional Features:

1. Ground Fault Circuit Interrupters (GFCI) – Specification grade, feed thru feature, solid-state ground fault sensing with 5mA trip level, and UL listed – 943 Class A. Hubbell Type GF5362.

2.04 RECEPTACLES – NEMA TWIST-LOCK RECEPTACLES

A. Face (top) shall be nylon with boss diameter of 1.56" on both 20 and 30 amp receptacles.

B. Face shall also have identifying color coding feature (color coding in accordance to IEC 309 standard) by voltage rating to assure proper mating of devices.

- C. Terminal screws shall be #10 silicone bronze and accommodate back or side wiring. 20 amp receptacle terminal shall be capable of accepting #8 AWG wire and provide wire restraint non-loosening design.
- D. Base shall be constructed of dimensionally stable, heat resistant material.
- E. Contact arm shall be one-piece (or riveted assembly) and shall also provide oxide cutting feature for termination integrity.

2.05 RECEPTACLES – WEATHERPROOF

- A. Weatherproof Receptacles: Shall consist of a duplex receptacle GFCI, mounted in box with a gasketed, weatherproof cover plate. The weatherproof integrity shall not be affected when heavy duty specification or hospital grade attachment plug caps are inserted. Receptacles shall be listed as weather resistant. Cover plates on outlet boxes mounted flush in the wall shall be gasketed to the wall in a watertight manner. Covers shall utilize a weatherproof when-in-use cover. Cover shall be extra duty die-cast metal Taymac MX3200 or equal by Intermatic or Thomas & Betts.

2.06 LIGHTING CONTROL SYSTEMS

- A. Manufacturers
 - 1. Wattstopper (Basis of Design)
 - 2. Cooper
 - 3. Hubbell
 - 4. Or equal as approved by the Professional
- B. Refer to drawing for additional information.
- C. To ensure quality and reliability, sensors shall be manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1%.
- D. Sensors shall have standard 5 year warranty and shall be UL and CUL listed.
- E. Dual technology wall switch occupancy sensor shall be Wattstopper DSW-301 or equal.
- F. Provide support for commissioning of lighting control system.

2.07 PHOTOCELLS

- A. Provide quick-response, cadmium sulfide, epoxy coated cell, 1 inch diameter type photocell with up to 120 second built-in time delay to prevent response from momentary lightning flashes, car headlights, or cloud movements. Energize photocells when light decreases to 1-5 fc and maintain system energized until light increases to 3-15 fc. Contacts to remain closed between dusk and dawn and unit should fail in the on position. Temperature range of –40F to 140F. Voltage and wattage ratings as noted or required. Equal to Torx ZB124WP.

2.08 WALL PLATES

- A. General: Cover plate shall be a single unit that mates and matches with corresponding wiring devices. Base pricing on type 430 brushed stainless steel finish.
- B. Acceptable manufacturers:
 - 1. Hubbell (Basis of Design)
 - 2. Arrow Hart
 - 3. Bryant
 - 4. Or equal as approved by the Professional

- C. In unfinished areas, use suitable pressed galvanized steel code gauge raised covers. Flat pressed galvanized steel code gauge covers used for junction boxes without devices.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify conditions.
- B. Verify outlet boxes are installed at proper height.
- C. Verify wall openings are neatly cut and will be completely covered by wall plates.
- D. Cover plates shall be mounted on all devices.
- E. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.02 PREPARATION

- A. Clean debris from outlet boxes.

3.03 INSTALLATION

- A. General: Install wiring devices as indicated, in accordance with manufacturer's written instructions, applicable requirements of NFPA 70 and NEMA "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements. Where not indicated, mount switch adjacent to latch jamb of door.
- B. Install devices plumb and level.
- C. Install switches with OFF position down.
- D. Install receptacles with grounding pole on top.
- E. All nonlocking-type, 125-volt, 15- and 20-ampere receptacles that are controlled by an automatic control device, or that incorporate control features that remove power from the receptacle for the purpose of energy management or building automation, shall be permanently marked with the symbol shown in NEC Figure 406.3(E) and the word "controlled." The marking shall be located on the receptacle face and visible after installation.
- F. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor
- G. Connect wiring devices by wrapping conductor around screw terminal.
- H. Install wall plates after painting has been completed.
- I. Group adjacent devices under a single, multigang wall plate.
- J. Switches shall be mounted on striker plate side of door. Contractor shall field verify location of striker plate prior to installation; adjust location accordingly.

- K. Incorporate barriers between switches with multigang outlet boxes where required by the NEC.
- L. Connectors and Terminals: Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors". Use properly scaled torque indicating hand tool.
- M. Switched duplex receptacles shall be wired so that only the top receptacle is switched the bottom receptacle shall be unswitched.

3.04 IDENTIFICATION

- A. Switches: Unless otherwise noted, where three (3) or more switches are ganged, identify each switch with approved legend engraved on wall plate.

3.05 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate locations of outlet boxes provided under Section 26 05 32 to obtain mounting heights indicated on drawings.

3.06 FIELD QUALITY CONTROL

- A. Inspect each wiring device for defects.
- B. Operate each wall switch with circuit energized and verify proper operation.
- C. Verify that each receptacle device is energized.
- D. Test each receptacle device for proper polarity.
- E. Test each GFCI receptacle device for proper operation.
- F. Replace damaged or defective components.

3.07 ADJUSTING

- A. Adjust devices and cover plates to be level.

END OF SECTION 262726

SECTION 262819
ENCLOSED SWITCHES

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 RELATED DOCUMENTS

- A. Applicable requirements of the Drawings, Owner/Contractor Agreement, General Conditions, Unified Facilities Criteria Standards, Supplementary Conditions, and Division 1 - General Requirements, are part of this Section and have the same force and effect as if printed herein in full.

1.03 SECTION INCLUDES

- A. Fusible switches.
- B. Nonfusible switches.
- C. Fuses.

1.03 REFERENCES

- A. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- B. NEMA FU 1 - Low Voltage Cartridge Fuses.
- C. NEMA Part ICSI-109
- D. UL 98
- E. Federal Specification WS 865 C.

1.04 SUBMITTALS

- A. NEMA Data: Provide switch ratings and enclosure dimensions.
- B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.05 OPERATION AND MAINTENANCE MANUALS

- A. Technical data sheets, maintenance data, and information for ordering replacement units and fuses.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. Eaton (Basis of Design)
- B. Siemens Energy and Automation Inc.
- C. Square D Co.
- D. Or equal as approved by the Professional

2.02 ENCLOSED SWITCHES

- A. Fusible Switch Assemblies: NEMA KS 1, heavy duty type load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Means shall be provided for disengaging the interlock for inspection and maintenance when the switch is ON. Handle lockable in OFF position with a padlock having a 1/4" shackle. Switch blade ends shall be visible when in the OFF position with the enclosure cover open. Fuse clips: Designed to accommodate Class R fuses. Switches serving as motor disconnect means shall be horsepower rated.
- B. Nonfusible Switch Assemblies: NEMA KS 1, heavy duty type load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position with a padlock having a 1/4" shackle. Switches serving as motor disconnect means shall be horsepower rated.
- C. Enclosures: NEMA KS 1.
 - 1. Interior Dry - NEMA 1; Damp or Wet NEMA 3R.
 - 2. Exterior Locations: Type 3R.
- D. Furnish switches with entirely copper current carrying parts.

2.03 FUSES

- A. Description: 600 volt, UL 198E, Class RK 1, Class RK5 (motor loads)
- B. Interrupting Rating: 200,000 rms amperes.

2.04 OPTIONS

- A. All disconnect switches provided on load side of variable frequency drives shall contain auxiliary contacts to shut down VFD upon opening of switch. Contacts shall activate before switch blades open. EC is responsible for coordinating all necessary interconnection wiring with the equipment manufacturers. Wiring between disconnect switch and VFD shall not be installed in the motor feeder conduit.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Perform work in accordance with NECA Standard of installation.
- B. Install disconnect switches where indicated.
- C. Install fuses in fusible disconnect switches.
- D. Provide label on inside door of each switch indicating NEMA fuse class and size for replacement, refer to Section 26 05 53.
- E. Provide label on outside door of each switch identifying load served and feeder circuit information. Refer to Section 26 05 53 – Electrical Identification.

END OF SECTION 262819

SECTION 263553
SURGE PROTECTIVE DEVICES

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. The Contractor shall furnish and install the Surge Protective Devices (SPD) equipment having the electrical characteristics, ratings and modifications as specified herein and as shown on the contract drawings. The ac surge protection shall be installed external to the main distribution panelboard.
- B. Section Includes:
 - 1. Surge Protective Devices.

1.3 REFERENCES

- A. Institute of Electrical and Electronics Engineers:
 - 1. IEEE 1100 - Recommended Practice for Powering and Grounding Electronic Equipment.
 - 2. IEEE C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits,
 - 3. IEEE C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits,
 - 4. IEEE C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits.
- B. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code.
 - 2. NFPA 780 - Standard for the Installation of Lightning Protection Systems.
- C. Underwriters Laboratories Inc.:
 - 1. UL 1283 - Electromagnetic Interference Filters.
 - 2. UL 1449 - Third Edition, effective September 29, 2009 – Surge Protective Devices.

1.4 SUBMITTALS

- A. Submit shop drawings and product information for approval and final documentation in the quantities listed according to the Conditions of the Contract. All transmittals shall be identified by customer name, customer location, and customer order number.
- B. Submittals shall include UL 1449 3rd Edition Listing documentation verifiable by visiting www.UL.com, clicking "Certifications" link, searching using UL Category Code: VZCA and VZCA2:
 - 1. Short Circuit Current Rating (SCCR)
 - 2. Voltage Protection Ratings (VPRs) for all modes
 - 3. Maximum Continuous Operating Voltage rating (MCOV)
 - 4. I-nominal rating (I-n)
 - 5. SPD shall be UL listed and labeled as Type 1 or Type 4 intended for Type 1 or Type 2 applications
- C. For sidemount mounting applications (SPD mounted external to electrical assembly), electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.
- D. Upon request, an unencapsulated but complete SPD formally known as TVSS shall be presented for visual inspection.
- E. Minimum of ten (10) year warranty

1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of transient voltage surge suppressors.
- B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, installation instructions, and maintenance and repair data.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Engage a firm with at least 5 years experience in manufacturing transient voltage surge suppressors.
- B. Manufacturer shall be ISO 9001 or 9002 certified.
- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of ten (10) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

- D. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

1.7 QUALIFICATIONS

- A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
- B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of manufacturer's instructions shall be included with the equipment at time of shipment.
- B. Accept equipment on site in factory packaging. Inspect for damage.
- C. Protect equipment from damage by providing temporary covers until construction is complete in adjacent space.

PART 2 PRODUCTS

2.1 SURGE PROTECTIVE DEVICES (SPD)

- A. Manufacturers:
 - 1. Eaton (Basis of Design)
 - 2. Siemens Energy & Automation, Inc.
 - 3. Square D Company
 - 4. Or equal as approved by the Professional
- B. Product Description: Surge protective devices for protection of AC electrical circuits.
- C. Types: Service entrance switchboards.
- D. Unit Operating Voltage: 208/120V.
- E. Maximum Continuous Operating Voltage (MCOV) – The MCOV shall be 125% of the nominal system operating voltage.

F. Construction:

1. Finish: Factory finish of baked enamel.
2. Balanced Suppression Platform: Equally distribute surge current to Metal Oxide Varistor (MOV) components to ensure equal stressing and maximum performance. Furnish surge suppression platform with equal impedance paths to each matched MOV.
3. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be hardwired with connections utilizing low impedance conductors and compression fittings.
4. Overcurrent Protection Fusing: In order to isolate the SPD under any fault condition, the manufacturer shall provide individual fusing for the MOVs
5. Safety and Diagnostic Monitoring: Equipped with standard overcurrent protection:
 - a. Continuous monitoring of fusing system.
 - b. Monitor individual MOV's (including neutral to ground). Capable of identifying open circuit failures not monitored by conventional fusing systems.
 - c. Monitor for overheating in each mode due to thermal runaway.
 - d. Furnish green and red solid state indicator light on each phase. Absence of green light and presence of red light indicates which phases have been damaged. Fault detection activates flashing trouble light. Units not capable of detecting open circuit damage, thermal conditions, and over current will not be accepted.
6. Labeling: Permanently affix UL 1449 3rd Edition suppression voltage ratings and CSA to unit.

G. Rating:

1. Electrical Noise Filter: Furnish each unit with high performance EMI/RFI noise rejection filter. Electric line noise attenuation no less than 45 dB at 100 kHz using MIL-STD-220A insertion loss test method.
2. Extended Range Filter –The Surge Protective Device shall have a High Frequency Extended Range Tracking filter in each Line to Neutral mode with compliance to UL 1283 and NEMA LS1. The filter shall have published high frequency attenuation rating in the attenuation frequencies.

Attenuation Frequency	50 kHz	100 kHz	500 kHz	1 MHz	10 MHz	100 MHz
Insertion Loss (ratio)	40	316	316	89	200	79
Insertion Loss (dB)	32	50	50	39	46	38

H. Accessories:

1. Each unit shall provide a green / red solid-state indicator light shall be provided on each phase. The absence of a green light and the presence of a red light, shall indicate which phase(s) have been damaged.

2. Audible Alarm – The SPD shall provide an audible alarm with a reset pushbutton that will be activated under any fault condition.
3. Remote Status Monitor – The SPD device must include Form C dry contacts (one NO and one NC) for remote annunciation of unit status. The remote alarm shall change state if any of the three phases detect a fault condition.
4. Remote monitor panel with indicating lights and audible alarm for mounting in remote location.
5. Push to Test – The SPD shall be equipped with push-to-test feature designed to provide users with real time testing of the suppressor's monitoring and diagnostic system. A test button shall be provided to initiate a self test procedure. If the system is fully operational, the self test will activate all indicator lights.
6. Event Counter – The SPD shall be equipped with an LCD display system designed to indicate to the user how many surges, sags, swells and outages have occurred at the location. The event counter triggers each time under each respective categories after significant event occurs. A reset pushbutton shall also be standard allowing all counters to be zeroed.
7. Non Volatile Memory – The SPD monitoring system shall be able to save 1000 events, including surges, sags, swells, and outages.
8. Voltage Monitoring – The SPD shall display true root mean square (rms) voltage line-to-line.

I. Optional Monitoring Diagnostics:

1. Network Communication – The SPD shall have the ability to communicate via Ethernet 10BaseT port or Modbus to provide information to the network master drive.
2. Security – The SPD monitoring diagnostics shall be password protected.
3. Protection Remaining – The SPD shall indicate the level of protection remaining.

J. Surge Current Capacity: Total surge current (based on 8 x 20 microsecond waveform) device is capable of surviving is not less than:

Application	Min Surge Current Per Phase	Min Surge Current Per Mode *
Service Entrance (Switchboards, Switchgear, MCC)	250 kA	125 kA
High Exposure Roof Top Locations	160 kA	80 kA
Distribution and branch locations (Panelboards, MCC, Bus Duct)	120 kA	60 kA
*L-G, L-N and N-G (WYE system); L-L, L-G (Delta system)		

K. Protection Modes: For Wye configured system, furnish device with directly connected suppression elements between line-neutral (L-N), line-ground (L-G), and neutral-ground (N-G). For Delta configured system, furnish device with suppression elements between line to line (L-L) and line to ground (L-G).

- L. Do not exceed the following for maximum UL 1449 suppression voltage ratings:

Modes	208Y/120	480Y/277	600Y/347
WYE - L-N; L-G; N-G	400 V	800 V	1200 V
Delta - L-L, L-G	800 V	1500 V	2000

- M. ANSI/IEEE Catalog C3 Let Through Voltage: Based on ANSI/IEEE C62.41 and C62.45 recommended procedures for Catalog C3 surges (20 kV, 10kA) and not less than:

Modes	208Y/120	480Y/277	600Y/347
L-N	500 V	900 V	1300

- N. ANSI/IEEE Cat. B3 Let Through Voltage: Based on ANSI/IEEE C62.41 and C62.45 recommended procedures for ANSI/IEEE Catalog B3 Ringwave (6 kV, 500 amps) not less than:

Modes	208Y/120	480Y/277	600Y/347
WYE - L-N; L-G; N-G	400 V	800 V	1200 V
L-N	170 V	300 V	470

- O. Minimum Repetitive Surge Current Capability as per ANSI/IEEE C62.41 and ANSI/IEEE C62.45 – 1992.

1. The suppression filter system shall be repetitive surge tested in every mode utilizing a 1.2 x 50µsec, 20 kV open circuit voltage. 8 x 20µsec, 10 kA short circuit current Category C3 bi-wave at one minute intervals without suffering either performance degradation or more than 10% deviation of clamping voltage at a specified surge current. The minimum repetitive surge current capability as per ANSI/IEEE C62.41 and ANSI/IEEE C62.45 – 1992 shall be:
 - a. Service Entrance: 12000 impulse per mode.
 - b. Distribution Panelboard: 10000 impulse per mode.
 - c. Branch Location Panelboard: 9000 impulse per mode.

2.2 SYSTEM APPLICATION

- A. Externally mounted SPD. Coordinate maximum conductor lead length and conductor type between breaker and suppressor. Comply with the manufacturer's recommended installation and wiring practices.

2.3 ENCLOSURES

- A. All enclosed equipment shall have NEMA 1/ 3R general purpose enclosures, unless otherwise noted. Provide enclosures suitable for locations as indicated on the drawings and as described below:

1. NEMA 1/3R rainproof enclosures intended for outdoor use primarily to provide protection against rain, sleet and damage from external ice formation.

2.4 SOURCE QUALITY CONTROL AND TESTS

- A. Test units to specified surge ratings to ensure devices will achieve required life expectancy and reliability. Testing to full ratings also verifies internal construction quality of suppressors. Provide withstand testing for each mode and each phase basis.
- B. Perform actual Let-Through voltage test data in form of oscillograph results for ANSI/IEEE C62.41 Catalog C3 (20 kV, 10 kA), Catalog C1 (6 kV, 3 kA), and Catalog. B3 (6 kV, 500 A at 100 kHz) tested in accordance with ANSI/IEEE C62.45.
- C. Perform spectrum analysis of each unit based on MIL-STD-220A test procedures between 50 kHz and 200 kHz verifying device noise attenuation exceeds 45 dB at 100 kHz.
- D. Perform test verifying suppressors can survive published surge current rating for each mode and each phase basis. Test wave based on ANSI/IEEE C62.41, 8x20 microsecond current wave.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify mounting area is ready for equipment.
- B. Verify circuit rough-ins are at correct location.

3.2 INSTALLATION

- A. The Contractors shall install all equipment per the manufacturer's recommendations and the contract drawings.
- B. Install in accordance with IEEE 1100.
- C. Install suppressor with internal fusing.

END OF SECTION 263553

SECTION 265000

LIGHTING

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 RELATED DOCUMENTS

- A. Applicable requirements of the Drawings, Owner/Contractor Agreement, General Conditions, Unified Facilities Criteria Standards, Supplementary Conditions, and Division 1 - General Requirements, are part of this Section and have the same force and effect as if printed herein in full.

1.03 GENERAL

- A. DESCRIPTION OF WORK - Provide a luminaire (lighting fixture) for each luminaire symbol shown and specified, complete with sockets reflectors, diffusers, shades, holders, lamps, ballasts, protective devices and all other required appurtenances.

1.04 SUBMITTALS

- A. Submittals shall be in the form of standard catalog cuts and factory assembly drawings, and shall indicate the following:
 - 1. Fixture type designation, manufacturer and manufacturer's catalog number.
 - 2. Lamp type, source, envelope, base phosphor color, wattage, voltage.
 - 3. Provide ballast cut sheet which shall include: ballast manufacturer, catalog number, ballast factor, wattage, type and voltage.
 - 4. Fixture voltage and wattage.
 - 5. Manufacturer's certified photometric data.
 - 6. Fixture dimensions, mechanical and electrical connections, pendants, and flanges.
 - 7. Layout and true dimensions of all fixtures installed in casework, architectural coves or specified for continuous housing and continuous light.
 - 8. Finish information (or sample if requested on or by the Lighting Fixture Schedule, Architect, or Engineer) for all components.
 - 9. Any deviation from the specification must be clearly identified.
 - 10. Dimming Ballast Compatibility Certificates: Signed by manufacturer of ballast certifying that ballasts are compatible with dimming systems and equipment with which they are used.

1.05 REFERENCE CODES AND STANDARDS

- A. Electrical Testing Laboratories (ETL)
- B. Underwriters Laboratories, Inc. (UL) labeling and/or listing.
- C. Certified Ballast Manufacturers (CBM).

- D. Independent Testing Laboratories Photometric Reports.
- E. ANSI C78.379 - Electric Lamps - Incandescent and High-Intensity Discharge Reflector Lamps - Classification or Beam Patterns.
- F. ANSI C82.1 - American National Standard for Lamp Ballast-Line Frequency Fluorescent Lamp Ballast.
- G. ANSI C82.4 - American National Standard for Ballasts-for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type).

1.06 QUALITY ASSURANCE

- A. All luminaires shall be the products of lighting equipment manufacturers who have previously demonstrated, by performance and reputation, the ability to manufacture products of the quality specified. Such manufacturers must maintain an organization and manufacturing facility capable of actually manufacturing the specified luminaires.

1.07 PROJECT RECORD DOCUMENTS

- A. Submit accurate records of actual locations of each luminaire.

1.08 OPERATION AND MAINTENANCE DATA

- A. Maintenance Data: Include replacement parts list.
- B. Include manufacturer's operation and maintenance manuals in the manual noted under 26 05 00.

PART 2 - PRODUCTS

2.01 LIGHTING FIXTURE SCHEDULE

- A. Lighting fixtures shall be as specified in the schedule located in the specifications. The listed manufacturer is the basis of design. All lighting calculations were performed using the basis of design manufacturer. Approved equal manufacturers are acceptable. If an alternate light fixture manufacturer is selected, provide both normal and emergency lighting calculations for engineer review with light fixture shop drawings. If lighting calculations are not provided with an alternate manufacturer's shop drawings, shop drawings will be returned without review.
- B. Manufacturers:
 - a. Acuity (Basis of Design)
 - b. Hubbell
 - c. Columbia
 - d. Prescolite
 - e. Or equal as approved by the Professional

2.02 LUMINAIRES

- A. All luminaires are located, detailed, and identified on the drawings, and specified in The Lighting Fixture Schedule.
- B. The specified fixture shall be the first named manufacturer and the catalog number. Equivalent fixtures by the other manufacturers named will also be acceptable. Refer to 260500 for substitutions. If an alternate manufacturer is selected, provide lighting calculations for engineer review with light fixture shop drawings
- C. Luminaires shall be constructed and internally wired in compliance with all applicable national, state and local codes. Luminaires shall conform to UL Standards and to applicable codes exceeding those standards.
- D. Luminaires for use outdoors or in wet or damp locations shall be suitably gasketed to prevent access or moisture into electrical components, or enclosing diffusers, lenses, and globes. All metal parts of luminaires for use outdoors or in damp locations which are specified as requiring painting, shall be painted with suitable weather and moisture-resisting qualities equivalent to epoxy-based coating. All aluminum parts of luminaires for use outdoors or in damp locations which are not specified as requiring a painted finish shall be anodized.
- E. Recessed luminaires shall be constructed to be suitable for the ceiling material and construction in which they will be installed. The Contractor shall verify all ceiling construction with the Architect's room finish schedule before ordering luminaires or submitting fixtures for review shown or specified. Recessed fixtures shall have adjustable fittings to permit alignment with ceiling panels. Recessed fixtures installed in fire-resistive type of suspended ceiling construction shall have the same fire rating as the ceiling or shall be provided with fireproofing boxes having materials of the same fire rating as the ceiling panels, in conformance with UL-03.
- F. All recessed fixture housings shall be thermally protected.

2.03 FINISH

- A. All luminaires shall be provided with a standard finish as published on the manufacturer's data sheets, except where indicated otherwise. The statement, "Paint finish as selected by the Design Professional" shall indicate a finish which is not a manufacturer's standard.

2.04 ACCESSORIES

- A. Plaster or mounting frames shall be provided as required and shall be suitable for the ceiling construction in which they will be installed. The Contractor shall verify ceiling construction with the Architect Room Finish Schedule prior to ordering luminaires or submitting for Engineer's review.
- B. Luminaires shall be furnished with all necessary hardware (stems, mounting frames, hangers, etc.) for the safe and proper support of the luminaires. All supports for luminaires (stems, chains, anchors, hangers, etc.) shall be adequate to support the weight of the luminaires. The use of perforated band iron will not be permitted. All stem hangers shall be furnished with suitable aligner canopies or outlet box covers so that the luminaires hang vertical to the finished floor irrespective of the angle of the surface from which they are suspended. Where raceways and outlet boxes serving the luminaires are surface mounted to the ceiling or wall, finishing rings shall be provided, unless specifically indicated otherwise, to conceal the outlet box. All visible hanging devices and appurtenances shall have the same finish as the luminaire, unless specifically indicated otherwise.
- C. Pendants, rods, or chains 4 feet or longer shall be braced to limit swinging. Bracing shall be 3-directional, 120 degrees apart.

2.05 DRIVERS

- A. Drivers shall meet or exceed the following minimum criteria:
 - 1. Minimum power factor: 0.90.
 - 2. Maximum total harmonic distortion (THD): 10%.
 - 3. Rating: UL-P, "A" sound rated.
 - 4. Drivers shall tolerate operation in ambient temperatures up to 105°F (40°C) without damage.
- B. Drivers for outdoor use shall be low temperature type (-20°F).
- C. Manufacturer shall provide written warranty against defects in material or workmanship, including replacement, for at least a minimum of two years from date of manufacture.
- D. Drivers(s) shall have an in-line disconnect to meet NEC 410. Further require that the lighting manufacturer provide a "wire nut" connection on the load side of the disconnect to facilitate future ballast replacement.

2.06 DIFFUSERS

- A. Plastic lenses, diffusers, or shields specified shall be 100% virgin acrylic in sizes and shapes to properly fit the lighting fixture.

2.07 EMERGENCY POWER SUPPLY UNIT

- A. Internal Type: Self-contained, modular, battery-inverter unit factory mounted within fixture body. Comply with UL 924.
 - 1. Test switch and light-emitting diode indicator light: visible and accessible without opening fixture or entering ceiling space.
 - 2. Battery: Sealed, maintenance-free, nickel-cadmium type with 10-year nominal life.
 - 3. Charger: Fully automatic, solid-state, constant-current type.
 - 4. Operation: Relay automatically energizes lamp from unit when normal supply circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamp, and battery is automatically recharged and floated on charger.
 - 5. Unit shall provide full lumen output of a minimum of one lamp in the designated fixtures.
- B. External Type: Self-contained, modular, battery-inverter unit. Comply with UL 924.
 - 1. Test switch and light-emitting diode indicator light: visible and accessible without entering ceiling space.
 - 2. Battery: Sealed, maintenance-free, nickel-cadmium type with 10-year nominal life.
 - 3. Charger: Fully automatic, solid-state, constant-current type.
 - 4. Operation: Relay automatically energizes lamp from unit when normal supply circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamp, and battery is automatically recharged and floated on charger.
 - 5. Housing: NEMA 250, Class 1 enclosure.
 - 6. Unit shall provide full lumen output of a minimum of one lamp in the designated fixtures.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All luminaires shall be installed complete with lamps as specified and/or shown in the Lighting Fixture Schedule. Provide all equipment and materials for a complete and fully operating installation. Installation shall be in accordance with manufacturer's instructions.
- B. All luminaires, when installed, shall be set plumb and true, and shall be free of light leaks, warps, dents and other irregularities.
- C. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.
- D. Rows of luminaires recessed, surface or pendant mounted shall be installed accurately in a straight line and aligned with building lines.
- E. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.
- F. Install recessed luminaires to permit removal from below.
- G. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
- H. Support for Luminaries in or on Grid-Type Suspended Ceilings:
 - 1. Install a minimum of four ceiling support system rods or wires for each luminaire. Locate not more than 6 inches from luminaire corners.
 - 2. Support Clips: Fasten to luminaires and to ceiling grid members at or near each luminaire corner with clips that are UL listed for the application.
 - 3. All luminaires recessed or suspended from the ceiling shall be supported by the structure above the ceiling at a minimum of two locations for every four feet of luminaire length.
 - 4. Luminaries of size less than ceiling grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support luminaries independently with at least two $\frac{3}{4}$ inch metal channels spanning and secured to the ceiling tees. Install at least one independent support rod or wire from structure to a tab on luminaire. Wire or rod shall have breaking strength of the weight of the fixture at a safety factor of 3.
 - 5. Provide redundant supports to ensure that failure of a single supporting component does not result in luminaire falling. Mount overhead luminaires weighing more than 20 pounds (9 kilograms) with either rigid or flexible systems to reduce the likelihood that they will fall and injure building occupants or damage equipment. Ensure luminaires do not move horizontally in any direction more than 1 inch (25 mm) when subjected to force specified herein. Design equipment mountings to resist forces of 0.5 times the equipment weight in any horizontal direction and 1.5 times the equipment weight in the downward direction. This does not preclude the need to design equipment mountings for forces required by other criteria such as seismic design criteria of non-structural systems.
- I. Luminaires shall be installed at the mounting heights shown or as approved by the Architect. Pendant-mounted luminaires in the same room or area shall be installed at uniform height above the finished floor. Verify the mounting height of pendant-mounted fixtures with the Owner's Representative before any installation.
- J. Install specified lamps in each luminaire.
- K. Final focusing of adjustable luminaires shall be done under the direction of the Owner's Representative, including such focusing as may be necessary after regular working hours.
- L. Luminaires provided with adjustable lighting-regulation devices shall be adjusted after sunset to the satisfaction of the Owner, Architect, and Engineer. Include all costs in bids.

- M. Provide scaffolding and equipment, as required, for the focusing and/or adjustment of the lighting fixtures.
- N. Install concrete bases for lighting poles at locations as indicated on Drawings.
- O. Install poles plumb. Install double nuts to adjust plumb. Grout around each base.
- P. Bond and ground luminaires metal accessories, and metal poles. Install supplementary grounding electrode at each pole.

3.02 REJECTIONS

- A. Replace irregular, blemished, damaged, and unsatisfactory luminaires with new units.

3.03 TIMING OF INSTALLATION

- A. Reflectors, cones, aperture plates, lenses, diffusers, louvers, and decorative elements of luminaires shall not be installed until completion of plastering, ceiling tile work, painting and general clean-up in the area.

3.04 CLEANING

- A. Immediately prior to occupancy, clean all reflectors, cones, aperture plates, lenses, diffusers, louvers, lamps, and decorative elements. Upon completion of the installation of luminaires and at the time of final inspections, all luminaires shall be clean and free from defects in operation and appearance.

LIGHTING FIXTURE SCHEDULE								
FIXTURE TYPE	MOUNTING	DESCRIPTION	LAMPING	WATT	VOLTS	MANUFACTURER NAME	CATALOG NUMBER	REMARKS
A1	RECESSED	2X2 VOLUMETRIC DIMMABLE LED LIGHT	LED 2000LM 3500K	16.4	120/277	LITHONIA	2BLT2 20L ADP GZ10 LP835	
A1,EM	RECESSED	2X2 VOLUMETRIC DIMMABLE LED LIGHT WITH 10W SELF DIAGNOSTIC EMERGENCY BATTERY PACK	LED 2000LM 3500K	16.4	120/277	LITHONIA	2BLT2 20L ADP GZ10 LP835 E10WLCP	
A2	RECESSED	2X2 VOLUMETRIC DIMMABLE LED LIGHT	LED 3300LM 3500K	26.5	120/277	LITHONIA	2BLT2 33L ADP GZ1 LP835	
A2,EM	RECESSED	2X2 VOLUMETRIC DIMMABLE LED LIGHT WITH INTEGRAL 10W SELF DIAGNOSTIC EMERGENCY BATTERY PACK	LED 3300LM 3500K	26.5	120/277	LITHONIA	2BLT2 33L ADP GZ1 LP835 E10WLCP	

A3	RECESSED	2X2 VOLUMETRIC DIMMABLE LED LIGHT FIXTURE	LED 4000LM 3500K	31	120/277	LITHONIA	2BLT2 40L ADP GZ1 LP835	
A3,EM	RECESSED	2X2 VOLUMETRIC DIMMABLE LED LIGHT FIXTURE WITH INTEGRAL 10W SELF DIAGNOSTIC EMERGENCY BATTERY PACK	LED 4000LM 3500K	31	120/277	LITHONIA	2BLT2 40L ADP GZ1 LP835 E10WLCP	
B1	RECESSED	1X4 VOLUMETRIC DIMMABLE LED LIGHT FIXTURE	LED 2000LM 3500K	15.7	120/277	LITHONIA	BLT 20L ADP GZ1 LP835	
B1,EM	RECESSED	1X4 VOLUMETRIC DIMMABLE LED LIGHT FIXTURE WITH INTEGRAL 10W SELF DIAGNOSTIC EMERGENCY BATTERY PACK	LED 2000LM 3500K	15.7	120/277	LITHONIA	BLT4 20L ADP GZ1 LP835 E10WLCP	
C1	PENDANT	LED LOW BAY DIMMABLE LIGHT FIXTURE	LED 4000LM 3500K	30.5	120/277	LITHONIA	UFIT L48 4000LM MVOLT GZ10 35K	
C1,EM	PENDANT	LED LOW BAY DIMMABLE LIGHT FIXTURE WITH INTEGRAL 10W LUMEN EMERGENCY BATTERY PACK	LED 4000LM 3500K	30.5	120/277	LITHONIA	UFIT L48 4000LM MVOLT GZ10 35K ILB-CP10-HE-A	
C2	PENDANT	LED LOW BAY DIMMABLE LIGHT FIXTURE	LED 6000LM 3500K	44.4	120/277	LITHONIA	UFIT L48 6000LM MVOLT GZ10 35K	
C2,EM	PENDANT	LED LOW BAY DIMMABLE LIGHT FIXTURE WITH INTEGRAL 10W LUMEN EMERGENCY BATTERY PACK	LED 6000LM 3500K	44.4	120/277	LITHONIA	UFIT L48 6000LM MVOLT GZ10 35K ILB-CP10-HE-A	
C3	PENDANT	LED LOW BAY DIMMABLE LIGHT FIXTURE	LED 8000LM 3500K	59.8	120/277	LITHONIA	UFIT L48 8000LM MVOLT GZ10 35K	
C2,EM	PENDANT	LED LOW BAY DIMMABLE LIGHT FIXTURE WITH INTEGRAL 1200 LUMEN EMERGENCY BATTERY PACK	LED 8000LM 3500K	59.8	120/277	LITHONIA	UFIT L48 8000LM MVOLT GZ10 35K ILB-CP10-HE-A	
D1	PENDANT	LED ROUND DIMMABLE HIGH BAY LIGHT FIXTURE	LED 12,000/15000/ 18000LM 4000K	106	120/277	LITHONIA	CPRB AL013 MVOLT 40K 80CRI DWH	SET AT 15000 LUMENS
D1,EM	PENDANT	LED ROUND DIMMABLE HIGH BAY LIGHT FIXTURE WITH INTEGRAL 40 WATT EMERGENCY BATTERY PACK	LED 12,000/15000/ 18000LM 4000K	106	120/277	LITHONIA	CPRB AL013 MVOLT 40K 80CRI DWH	SET AT 15000 LUMENS

D2,EM	PENDANT	LED ROUND DIMMABLE HIGH BAY LIGHT FIXTURE WITH INTEGRAL 40 WATT EMERGENCY BATTERY PACK	LED 12,000/15000/ 18000LM 4000K	83	120/277	LITHONIA	CPRB AL013 MVOLT 40K 80CRI DWH	SET AT 12000 LUMENS
E1	SURFACE	CLX LED LINEAR LIGHT FIXTURE	LED 3000LM 3500K	19	120/277	LITHONIA	CLX L48 3000LM SEF RDL MVOLT GZ10 35K 80CRI WH	
E1,EM	SURFACE	CLX LED LINEAR LIGHT FIXTURE WITH INTEGRAL 10W SELF DIAGNOSTIC EMERGENCY BATTERY PACK	LED 3000LM 3500K	19	120/277	LITHONIA	CLX L48 3000LM SEF RDL MVOLT GZ10 35K 80CRI WH E10WLCP	
F1	SURFACE	LED OUTDOOR SURFACE MOUNTED LIGHT FIXTURE WITH MOTION SENSOR	LED 2000LM 4000K	22	120	LEGION	9141L 022L 40 120 BL MS	
F1,EM	SURFACE	LED OUTDOOR SURFACE MOUNTED LIGHT FIXTURE WITH MOTION SENSOR AND INTEGRAL EMERGENCY BATTERY	LED 2000LM 4000K	22	120	LEGION	9141L 022L 40 120 BL MS EM	
G1	SURFACE	EXTERIOR LED WALL SCONCE WITH MOTION SENSOR AND PHOTOCELL.	LED 1200LM 4000K	10	120/277	LITHONIA	WDGE2 LED P1SW 40K 80CRI VW MVOLT PIR1FC3V DBLXD	
G1,EM	SURFACE	EXTERIOR LED WALL SCONCE WITH MOTION SENSOR AND PHOTOCELL WITH 18 WATT -20C INTEGRAL EMERGENCY BATTERY.	LED 1200LM 4000K	10	120/277	LITHONIA	WDGE2 LED P1SW 40K 80CRI VW MVOLT PIR1FC3V DBLXD E20WC	
G2	SURFACE	EXTERIOR LED WALL SCONCE WITH MOTION SENSOR AND PHOTOCELL.	LED 2000LM 4000K	15	120/277	LITHONIA	WDGE2 LED P2SW 40K 80CRI VW MVOLT PIR1FC3V DBLXD	
G2,EM	SURFACE	EXTERIOR LED WALL SCONCE WITH MOTION SENSOR AND PHOTOCELL WITH 18 WATT -20C INTEGRAL EMERGENCY BATTERY.	LED 2000LM 4000K	15	120/277	LITHONIA	WDGE2 LED P2SW 40K 80CRI VW MVOLT PIR1FC3V DBLXD E20WC	
H1	RECESSED	6" WAFER LED DOWNLIGHT, WET LOCATION LISTED.	LED 1040/1150/1110LM 2700/3000/3500	14	120	LITHONIA	WF6 LED 27K30K35K 90CRI MW M6	SET AT 3500K.

J1	PENDANT	36" ROUND SUSPENDED LED LIGHT FIXTURE	LED 3500K	71.9	120/277	BETA CALCO	RNGP3 LPF055 LPG027 CR80 CTA35 CTB35 UD1 V1 DA01 DB01 SS1 FA01 CF01 AP00	
J1,EM	PENDANT	36" ROUND SUSPENDED LED LIGHT FIXTURE WITH EMERGE CNY DRIVER	LED 3500K	71.9	120/277	BETA CALCO	RNGP3 LPF055 LPG027 CR80 CTA35 CTB35 UD1 V1 DA01 DB01 SS1 FA01 CF01 AP00 E1	
J2	PENDANT	24" ROUND SUSPENDED LED LIGHT FIXTURE	LED 3500K	71.9	120/277	BETA CALCO	RNGP2 LPF055 LPG027 CR80 CTA35 CTB35 UD1 V1 DA01 DB01 SS1 FA01 CF01 AP00	
K1	WALL	SMALL SURFACE MOUNTED POINT SOURCE ASYMMETRIC LED WITH INTEGRAL VISOR AND REMOTE DRIVER	LED 2081LM 3500K	15	120/277	ELLIPTIPAR	S100-S-14-X-02-M- 00-0-935-ZX- VCT-02-30-0	
X1	SURFACE	EXIT SIGN, THERMOPLASTIC, NICKEL CADMIUM BATTERY, SELF- DIAGNOSTICS	LED	0.71	120/277	LITHONIA	LQM-S-W-3-R- MVOLT-EL N-SD	CONNECT TO NON-SWITCHED ROOM LIGHTING CIRCUIT.

END OF SECTION 265000

SECTION 284600

FIRE ALARM 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 RELATED DOCUMENTS

- A. Applicable requirements of the Drawings, Owner/ Contractor Agreement, General Conditions, Supplementary Conditions, Division 1 - General Requirements, and Unified Facilities Criteria Standards are part of this Section and have the same force and effect as if printed herein in full.

1.3 SCOPE

- A. This specification document provides the requirements for the installation, programming and configuration of a complete Honeywell Farenhyt Series IFP-300ECS digital protocol analog addressable fire alarm system with integrated Emergency Communication System capabilities (ECS). This system shall include, but not be limited to, system cabinet, power supply, voice command module, microphone, built in Signaling Line Circuit (SLC), 160 character LCD annunciator, four programmable notification circuits, built in dual line, IP and optional cellular digital communicator associated peripheral devices, batteries, wiring, conduit and other relevant components and accessories required to furnish a complete and operational life safety system.

1.4 WORK INCLUDED

A. General Requirements

- 1. The contractor shall furnish and install a complete 24 VDC, electrically supervised, analog addressable fire alarm system with emergency communication as specified herein and indicated on the drawings. The system shall include but not be limited to all control panels, audio amplifiers, power supplies, initiating devices, audible and visual notification appliances, alarm devices, and all accessories required to provide a complete operating fire alarm, carbon monoxide alarm and emergency communication system.

B. Listings

- 1. All fire alarm system equipment shall be listed for it's intended purpose and be compatibility listed to assure the integrity of the complete system.

1.5 STANDARDS

- A. The fire alarm equipment and installation shall comply with the current provisions of the following standards and shall be listed for it's intended purpose and be compatibility listed to insure integrity of the complete system.

- 1. National Electric Code, Article 760

2. National Fire Protection Association Standards:

NFPA 70	National Electrical Code
NFPA 72	National Fire Alarm and Signaling Code
NFPA 101	Life Safety Code
NFPA 720	Standard for the Installation of CO Detection

3. Local and State Building Codes - BOCA, National Building Code, Mechanical Code, Fire Prevention Code

4. Local Authorities Having Jurisdiction

5. Underwriters Laboratories Inc.

- a. All equipment shall be approved by Underwriters Laboratories, Inc. for its intended purpose, listed as power limited by Underwriters Laboratories, Inc., for the following standards as applicable:

UL 864 UOJZ	Control units for Fire Protective Signaling Systems Local Signaling Unit Central Station Signaling Protected Premises Unit Remote Signaling Protected Premises Unit. Water Deluge Releasing Unit
UL 2572	Mass Notification Standard
UL 2075	CO Detectors Connected to FACP
UL 268	Smoke Detectors for Fire Protective Signaling systems
UL 268A	Smoke Detectors for duct applications
UL 217	Smoke Detectors for Single Stations
UL 521	Heat Detectors for Fire Protective Signaling systems
UL 228	Door Holders for Fire Protective Signaling systems
UL 464	Audible Signaling appliances
UL 1638	Visual Signaling appliances
UL 38	Manually Activated Signaling Boxes
UL 346	Waterflow indicators for Fire Protective Signaling systems
UL 1481	Power Supplies for Fire Protective Signaling systems.
UL1711	Amplifiers for Fire Protection Signaling Systems

6. Americans with Disabilities Act (ADA)

- a. All visual Notification appliances and manual pull stations shall comply with the requirements of the Americans with Disabilities Act.

1.6 GENERAL REQUIREMENTS

A. Manufacturers/Distributors Services

1. The following supervision shall be provided by a factory trained service technician from the distributor of the fire alarm equipment. The technician shall be trained and shall have a minimum of two (2) years of service experience in the fire alarm industry. The technicians name shall appear on equipment submittals and a copy of his manufactures trained shall be sent to the project engineer. The technician shall be responsible for the following items:
 - a. A pre installation visit to the job site to review equipment submittals and to verify the method by which the system is to be wired.
 - b. During the installation the certified technician shall be on site or make periodic visits to verify installation and wiring of the system. He shall also supervise the completion of conduit rough, wires pulled into conduit and wiring rough, and ready for trim.

- c. Upon completion of wiring, final checkout and certification of the system shall be made under the supervision of this technician.
- d. At the time of the formal checkout, technician shall give operational instructions to the owner and or his representative on the system.

B. Submittals

1. The contractor shall submit three (3) complete sets of documentation within thirty (30) calendar days after award of the purchase order. Indicated in the document will be the type, size, rating, style, catalog number, manufacturer's names, photos, and /or catalog data sheets for all items proposed to meet these specifications. The proposed equipment shall be subject to the approval of the Architect/Engineer and no equipment shall be ordered or installed on the premises without that approval.
2. Provide detailed working drawings, including, but not limited to plans, details, wiring diagrams, and riser diagram for the system provided.
3. Submit wiring diagrams and schematics showing points of connection and terminals used for all electrical field connections in the system.
4. Submit substantiating calculations showing battery capacity for supervisory and alarm requirements.
5. Submittal of shop drawings shall contain at least three (3) copies of original manufacturer specification and installation instruction sheets. Subsequent information may be copies. All equipment and devices on the shop drawings to be furnished under this contract shall be clearly marked in the specification sheets.
6. Supplier qualifications shall be submitted indicating years in business, service policies, warranty definitions, NICET certification, and completion of factory training program and a list of similar installations.
7. Contractor qualifications shall be supplied indicating years in business and prior experience with installations that include the type of equipment that is to be supplied.
8. The contractor shall provide hourly service rates, performed by a factory trained technician for this installed life safety system with the submittal. Proof of training and authorization shall be included with the submittal. These hourly service rates shall be guaranteed for a 1-year period.

C. Contract Close-out Submittals

1. Deliver two (2) copies of the following to the owner's representative within Thirty (30) days of system acceptance. The closeout submittals shall include:
 - a. Installation and Programming manuals for the installed life safety system.
 - b. Point to point diagrams of the entire life safety system as installed. This shall include all connected smoke detectors and addressable field modules.
 - c. All drawings must reflect device address as verified in the presence of the engineer and/or end user.

D. Warranty

Unless otherwise specified, all materials, installation and workmanship shall have a warranty for a three (3) year period. A copy of the manufacturer warranty shall be provided with the close out documentation.

E. Products

1. This life safety system specification must be conformed to in its entirety to ensure that the installed and programmed life safety system will accommodate all of the requirements and operations required by the building owner. Any specified item or operational feature not specifically addressed prior to the bid date will be required to be met without exception.

2. Submission of product purported to be equal to those specified herein will be considered as possible substitutes only when all of the following requirements have been met:
 - a. Any deviation from the equipment, operations, methods, design or other criteria specified herein must be submitted in detail to the specifying architect or engineer a minimum of ten (10) working days prior to the scheduled submission of bids. Each deviation from the operation detailed in these specifications must be documented in detail, including page number and section number, which list the system function for which the substitution is being proposed.
 - b. A complete list of such substituted products with three (3) copies of working drawings thereof shall be submitted to the approved Architect and/or Consulting Engineer not less than ten (10) working days prior to the scheduled submission of bids.
 - c. The contractor or substitute bidder shall functionally demonstrate that the proposed substitute products are in fact equal in quality and performance to those specified herein.

F. General Equipment and Materials Requirements

1. All equipment furnished for this project shall be new and unused. All components shall be designed for uninterrupted duty. All equipment, materials, accessories, devices and other facilities covered by this specification or noted on the contract drawings and installation specification shall be best suited for the intended use and shall be provided by a single manufacturer. If any of the equipment provided under this specification is provided by different manufacturers, then that equipment shall be "Listed" as to its compatibility by Underwriters Laboratories (UL), if such compatibility is required by UL standards.

G. Satisfying the Entire Intent of these Specifications

1. It is the contractor's responsibility to meet the entire intent of these specifications. Deviations from the specified items shall be at the risk of the contractor until the date of final acceptance by the architect, engineer and owner's representative. All costs for removal, relocation, or replacement of a substituted item shall be at the risk of the electrical contractor.

PART 2 - PRODUCTS

2.1 General

A. Control Panel with Emergency Communication System

1. The fire alarm control panel (FACP) shall be the Honeywell Farenhyt Series IFP-300ECS analog addressable fire alarm control panel and emergency communication system. The audio amplifiers shall be the Honeywell Farenhyt Series ECS-50W, ECS-125W, ECS-INT50W or ECS-DUAL50W voice evacuation units. The FACP must have a 6 amp power supply and be capable of expansion to a minimum of 102 total amps via bus connected expander modules that supervise low battery, loss of AC and loss of communication.
2. The system must contain at least one (1) Honeywell Farenhyt Series ECS-50W, ECS-125W, ECS-INT50W or ECS-DUAL-50W amplifier and shall be expandable from 50 to 1000 watts utilizing up to 7 additional amplifiers. The ECS-50W and ECS-125W amplifiers shall be capable of adding a 4 zone splitter (ECS-CE4) to distribute the audio information to different locations in the installation. The system shall have the capability of controlling up to 40 notification zones. The amplifiers must contain the capability of being remotely located through a four-wire SBUS communications circuit and a two-wire VBUS voice circuit. The system shall have the capability of adding up to 7 ECS-LOCs local operating consoles.
3. The voice evacuation system must have the capability of downloading fifteen (15) 60 second messages and utilize DSP technology for higher audio intelligibility.

4. The voice evacuation system shall be capable of operating at 25vrms or 70.7vrms (ECS-50W, ECS-INT50W and ECS-DUAL50W only) and must be field selectable at the amplifier level. Systems that require additional modules for voltage conversion shall not be accepted.
5. The FACP must have Day/Night sensitivity capabilities on detectors and be capable of supporting up to 300 analog addressable points. This shall be accomplished via signaling line circuits (SLC) capable of supporting a minimum of 159 detectors and 159 module devices each. The main panel will contain one SLC circuit with the option of utilizing a 6815 expander module. The communication protocol on the SLC loop must be digital.
6. The FACP must support a minimum of four programmable notification circuits. The panel must have a built in 160 character LCD annunciator with the capability of having an additional supervised remote annunciators connected in the field.
7. The FACP must have a built in UL approved IP and digital communicator with the option of adding a cellular module for communications. The communicator must allow local and remote up/downloading of system operating options, event history, and detector sensitivity data.
8. The FACP must automatically test the smoke detectors in compliance with NFPA standards to ensure that they are within listed sensitivity parameters and be listed with Underwriters Laboratories for this purpose.
9. The FACP must compensate for the accumulation of contaminants that affect detector sensitivity. The FACP must have day/night sensitivity adjustments, maintenance alert feature (differentiated from trouble condition), detector sensitivity selection, auto-programming mode (Jumpstart) and the ability to upgrade the core programming software on site or over the telephone.
10. The main communication bus (SBUS RS485) shall be capable of class A or class B configuration with a total SBUS length of 6,000 feet.
11. The FACP shall have a Jumpstart feature that can automatically enroll all properly connected accessories into a functional system.
12. The FACP must have the ability to upgrade the firmware revision from a laptop where the FACP is installed.
13. Panels that do not have these capabilities will not be accepted.

B. System Wiring

1. The Signaling Line Circuit (SLC) and Data Communication Bus (SBUS) shall be wired with standard NEC 760 compliant wiring. No twisted, shielded or mid capacitance wiring is required for standard installations. All FACP screw terminals shall be capable of accepting 14-18 AWG wire. All system wiring shall be in accordance with the requirements of NFPA 70, the National Electrical Code (NEC) and also comply with article 760 of the NEC.

C. Signaling Line Circuits

1. Each SLC shall be capable of a wiring distance of 5,000 feet from the panel or SLC driver module (6815) and be capable of supporting 318 devices. The communication protocol to SLC devices must be digital. Any SLC loop device, which goes into alarm, must interrupt the polling cycle for priority response from the FACP. The FACP must respond consistently to a device that goes into alarm on an SLC within 10 seconds. The auxiliary 6815 SLC loop module must be capable of being located up to 6,000 feet from the FACP on a SBUS, which is separate from the SLC. The SLC shall be capable of functioning in a class A or class B configuration.

D. SLC Loop Devices

1. Devices supported must include analog photoelectric, analog heat detectors, addressable input modules, relay output modules, addressable notification modules or wireless gateway. Each SLC loop shall support up to 159 detectors and 159 modules.

E. Analog Detector Functions

1. The products of combustion detectors must communicate analog values using a digital protocol to the control panel for the following functions:
 - Automatic compliance with NFPA 72 standards for detector sensitivity testing
 - Drift compensation to assure detector is operating correctly
 - Maintenance alert when a detector nears the trouble condition
 - Trouble alert when a detector is out of tolerance

F. Sensitivity Function

1. The FACP shall have the ability to set three different sensitivity levels. A zone can be programmed to a day and a night sensitivity value. The day/night schedule shall allow for 16 holiday dates that are user programmable to allow the FACP to respond at the night level on those days.

G. Programmable Notification Circuits

1. The FACP shall support four programmable notification circuits that are capable of being programmed as supervised reverse polarity notification circuits or supervised auxiliary power circuits that can be programmed as continuous, resettable or door holder power. The circuits can be configured as four Class B outputs, two Class B and one Class A outputs or two Class A outputs.

H. Addressable Notification Module

1. The contractor shall furnish and install where indicated on the plans, addressable notification modules, Honeywell Farenhyt Series Model IDP-CONTROL or SK-CONTROL. The modules shall be U.L. listed compatible with Honeywell Farenhyt Series IFP-300ECS fire alarm control panel. The notification module must provide one class A (Style Z) or class B (Style Y) notification output with one auxiliary power input. The notification module must be suitable for mounting in a standard 4 square electrical box and must include a plastic cover plate. The notification module must provide an LED that is visible from the outside of the cover plate. The notification module must be fully programmable for such applications as required by the installation. The IDP-CONTROL or SK-CONTROL shall reside on the SLC loop and can be placed up to 5,000 feet from the control or 6815 SLC loop module.

I. Annunciator

1. The main control must have a built in annunciator with a 160-character LCD display and feature LED's for Alarm, Supervisory, Trouble, Silenced and Power. When in the normal condition the LCD shall display time and date based on a 200 year clock which is capable of automatic daylight savings time adjustments. All controls and programming keys are silicone mechanical type with tactile and audible feedback. Keys have a travel of .040 in. No membrane style buttons will be permissible. The annunciator must be able to silence and reset alarms. The annunciators must have twenty levels of user codes that will allow the limitation of operating system programming to authorized individuals.

J. Remote Annunciators

1. The fire system shall be capable of supporting remote annunciators. LCD Remote annunciator, Model RA-2000, shall have the same control and display layout so that they match identically the built in annunciator. Remote annunciators shall be available in two colors, red and light gray. Remote annunciators shall have the same functionality and operation as the built-in annunciator. All annunciators must have 160-character LCD displays and must feature five

LED's for Alarm, Supervisory, Trouble, Silenced, and Power. All controls and programming keys are silicone mechanical type with tactical and audible feedback. Keys shall have a travel of .040 inches. No membrane style buttons will be permitted.

2. The annunciator must be able to silence and reset alarms. The annunciator must have twenty levels of user codes that will limit the operating system programming to authorized individuals. The control panel must allow all annunciators to accommodate multiple users input simultaneously. Remote annunciators shall be capable of operating at a distance of 6,000 feet from the main control panel on unshielded, non-twisted cable.

K. I/O Module

1. The fire system shall be able to support I/O modules (SK5880) that shall be used to drive remote LED graphic style displays and accommodate up to eight dry contact type switch inputs, including ECS inputs. The I/O modules shall each drive up to 40 LEDs without requiring external power connections. The I/O module inputs shall be supervised and be suitable for alarm and trouble circuits as well as reset and silence switches. The system shall also support up to 40 LED drivers that reside on the two-wire SLC loop. These driver boards shall contain 80 LED outputs that are powered by an external power source.

L. Serial/Parallel Interface

1. The fire system shall be capable of supporting up to two serial/parallel interfaces (SK5824) that are capable of driving standard computer style printers. The interface shall be programmable for the serial and parallel ports and allow printing of events as they occur.

M. Distributed Power Modules

1. The contractor shall supply power modules, Models RPS-1000 and 5496, compatible with the IFP-300ECS fire alarm control panel. The RPS-1000 power module must have 6 amps of output power, six Flexput™ circuits rated at 3amps each, and two form C relay circuits rated at 2.5 amps at 24 volts DC. The six Flexput™ circuits shall be capable of being programmed as supervised reverse polarity notification circuits or supervised auxiliary power circuits that can be programmed as continuous, resettable or door holder power. The circuits shall also be programmable as input circuits in class A or B configurations to support dry contact or compatible two wire smoke detectors.
2. The RPS-1000 shall be capable of being connected via an RS-485 system bus (SBUS) at a maximum distance of 6,000 feet from the main control panel. The RPS-1000 shall contain an additional RS-485 bus that is completely compatible with all IFP-300ECS add on modules; including 6815 SLC expanders, RA-2000-SK5865-SK5880 annunciators, 5824 serial/parallel module and addressable devices. The RPS-1000 will also act as a bus repeater so that additional RS-485 (modules) devices can be connected at a maximum distance of 6,000 feet from the power module.
3. The 5496 power module must have 6 amps of output power and four circuits rated at 3 amps each. The four circuits can be programmed as notification outputs or auxiliary power outputs of door holder, constant and resettable types.

N. Digital Communicator

1. The digital/IP communicator must be an integral part of the control panel and be capable of reporting all zones or points of alarm, supervisory, and trouble as well as all system status information such as loss of AC, low battery, ground fault, loss of supervision to any remote devices with individual and distinct messages to a central station or remote station. The communicator must also be capable of up/downloading of all system programming options, event history and detector sensitivity compliance information to a PC on site or at a remote location.

2. The communicator shall transmit the information by one or more of the following means of communication – internet, cellular or standard telephone lines. The communicator must be capable of reporting via SIA and Contact ID formats. The communicator shall have a delayed AC loss report function which will provide a programmable report delay plus a 10-25 min random component to help ease traffic to the central station during a power outage. No controls that use external modems for remote programming and diagnostics shall be accepted.

O. Dry Contacts

1. The FACP will have three form “C” dry contacts, one will be dedicated to trouble conditions, the other two will be programmable for alarm, trouble, sprinkler supervisory, notification, pre-alarm, waterflow, manual pull, aux. 1 or aux. 2. The trouble contact shall be normal in an electrically energized state so that any total power loss (AC and battery) will cause a trouble condition. In the event that the microprocessor on the FACP fails the trouble contacts shall also indicate a trouble condition.

P. Ground Fault Detection

1. A ground fault detection circuit shall be used to detect positive and negative grounds on all field wiring. The ground fault detector shall operate the general trouble devices as specified but shall not cause an alarm to be sounded. Ground faults will not interfere with normal operation, such as alarm, or other trouble conditions.

Q. Overcurrent Protection

1. All low voltage circuits will be protected by microprocessor controlled power limiting or have a self restoring polyswitches for the following: smoke detector power, main power supply, indicating appliance circuits, battery standby power and auxiliary output.

R. Test Functions

1. A “Lamp Test” mode shall be a standard feature of the fire alarm control panel and shall test all LED’s and the LCD display on the main panel and remote annunciators.
2. A “Walk Test” mode shall be a standard feature of the fire alarm control panel. The walk test feature shall function so that each alarm input tested will operate the associated notification appliance for 6 to 180 seconds. The FACP will then automatically perform a reset and confirm normal device operation. The event memory shall contain the information on the point tested, the zone tripped, the zone restore and the individual points return to normal.
3. A “Fire Drill” mode shall allow the manual testing of the fire alarm system notification circuits. The fire drill shall be capable of being controlled at the main annunciator, remote annunciators and via a remote contact input.
4. A “Bypass Mode” shall allow for any point or NAC circuit to be bypassed without effecting the operation of the total fire system.

S. Remote Input Capabilities

1. The control panel shall have provisions for supervised switch inputs for the purpose of alarm reset and alarm and trouble silence.

T. Notification Appliance Mapping Structure

1. All notification circuits and modules shall be programmable via a mapping structure that allows for a maximum of 999 output groups. Each of these groups shall have the ability to be triggered by any of the panels 999 zones, panel wide events, or site wide events. Additionally each zone,

panel, or site will individually control the cadence pattern of each of the groups that it is mapped to so that devices can indicate a variety of conditions. The zone, panel, or site shall be capable of issuing a different cadence pattern for each of the groups under its control. The mapping structure must also allow a group to be designated to "ignore cadence" for use with strobes and other continuous input devices. Zones shall have ten different output categories; Detector Alarm, Trouble, Supervisory, Pre-alarm, Waterflow, Manual Pull, Zone Auxiliary 1 and Zone Auxiliary 2, CO Alarm and CO Supervisory.

2. Each of the categories shall have the ability to control output groups with a cadence pattern. The patterns are; March code, ANSI 3.41, Single Stroke Bell Temporal, California Code, Zone 1 Coded, Zone 2 Coded, Zone 3 Coded, Zone 4 Coded, Zone 5 Coded, Zone 6 Coded, Zone 7 Coded, Zone 8 Coded, Custom Output Pattern 1, Custom Output Pattern 2, Custom Output Pattern 3, Custom Output Pattern 4, Constant, System Sensor Synchronization, Wheelock Synchronization, Gentex Synchronization, Amseco Synchronization, and Faraday Synchronization. This mapping/cadence pattern shall be supported by all system power supplies. 15 recordable one minute messages are available that can be mapped to eight ECS buttons. ECS messages can have priority over fire alarm outputs.

U. On-board Programmer

1. The FACP shall have an on board programmer which will allow for all system functions and options, except for mapping, to be programmed via the on board annunciator keypad. Any panel that does not have this capability will not be accepted.

V. Downloading Software

1. The fire alarm control panel must support up/downloading of system programming from a PC. The FACP must also be able to download the detector sensitivity test results and a 1,000 event system event buffer to the PC. Communication shall take place over a direct connection to the PC and/or via the same communication method as the built in digital communicator and shall not require an external modem to be connected to the panel. The downloading software shall contain a code that will block unauthorized persons from accessing the panel via direct connection or over the phone lines.

W. English Language Descriptions

1. The FACP shall provide the ability to have a text description of each system device, input zone and output group on the system. The use of individual lights to provide descriptions will not be acceptable.

2.2 SYSTEM OPERATION

A. Alarm

1. When a device indicates any alarm condition the control panel must respond within 10 seconds. All programmed audio and visual devices will activate at this time. The Alarm or Supervisory LED on the annunciator(s) should light and the LCD should prompt the user as to the number of current events. The alarm information must be stored in event memory for later review. Event memory must be available at the main and all remote annunciators.
2. When the alarmed device is restored to normal, the control panel shall be required to be manually reset to clear the alarm condition, except that the alarms may be silenced as programmed.
3. An alarm shall be silenced at the main or remote annunciators. When silenced, this shall not prevent the resounding of subsequent events if another event should occur (subsequent alarm feature). When alarms are silenced the silenced LED on the control panel, and on any remote annunciators shall remain lit, until the alarmed device is returned to normal.

B. Troubles

1. When a device indicates a trouble condition, the control panel System Trouble LED should light and the LCD should prompt the user as to the number of current events. The trouble information must be stored in event memory for later review. Event memory must be available at the main and all remote annunciators.
2. When the device in trouble is restored to normal, the control panel shall be automatically reset. The trouble restore information must be stored in event memory for later review. Event memory must be available at the main and all remote annunciators. A trouble shall be silenced at the main or remote annunciators. When silenced, this shall not prevent the resounding of subsequent events if another event should occur.

C. Supervision Methods

1. Each SLC loop shall be electrically supervised for opens and ground faults in the circuit wiring, and shall be so arranged that a fault condition on any loop will not cause an alarm to sound. Additionally, every addressable device connected to the SLC will be supervised and individually identified if in a fault condition. The occurrence of any fault will light a Trouble LED and sound the system trouble sounder, but will not interfere with the proper operation of any circuit which does not have a fault condition.
2. Each indicating appliance circuit shall be electrically supervised for opens, grounds and short circuit faults, on the circuit wiring, and shall be so arranged that a fault condition on any indicating appliance circuit or group of circuits will not cause an alarm to sound. The occurrence of any fault will light the trouble LED and sound the system trouble sounder, but will not interfere with the proper operation of any circuit which does not have a fault condition.

2.3 SYSTEM COMPONENTS

A. CONTROL UNIT

1. System Cabinet
 - a. Mounting
 - b. The system cabinets shall be red and can be either surface or flush mounted.
2. Audible System Trouble Sounder
 - a. An audible system trouble sounder shall be an integral part of the control unit. Provisions shall also be provided for an optional supervised remote trouble signal.

B. Power Supply and Charger

1. The entire system shall operate on 24 VDC, filtered switch mode power supply with the rated current available of 6 Amps. The FACP must have a battery charging circuit capable of complying with the following requirements:
2. Forty-eight (48) hours of battery standby with fifteen (15) minutes of alarm signaling at the end of this forty-eight (48) hour period using rechargeable batteries with automatic charger to maintain gel-cell batteries in a fully charged condition.
3. The power supply shall comply with U.L. Standard 864 for power limiting.
4. The FACP will indicate a trouble condition if there is a loss of AC power or if the batteries are missing or of insufficient capacity to support proper system operation in the event of AC failure. A "Battery Test" will be performed automatically every minute to check the integrity of the

batteries. The test must disconnect the batteries from the charging circuit and place a load on the battery to verify the battery condition.

5. In the event that it is necessary to provide additional power one or more of the Model RPS-1000 or 5496 distributed power modules shall be used to accomplish this purpose.

C. Connections and Circuits

1. Connections to the light and power service shall be on a dedicated branch circuit in accordance with the National Fire Alarm Code NFPA 72, National Electrical Code (NEC) NFPA 70, and the local authority having jurisdiction (AHJ). The circuit and connections shall be mechanically protected.
2. A circuit disconnecting means shall be accessible only to authorized personnel and shall be clearly marked "FIRE ALARM CIRCUIT CONTROL".

2.4 ACCESSORY COMPONENTS

1. The FACP shall support the following devices on the RS-485 data bus:

ECS-NVCM	Network Voice Control Module
ECS-SW24	Additional 24 Zone Switch Module
ECS-50W50	Watt Amplifier
ECS-125W	125 Watt Amplifier
ECS-DUAL50W	50/100 Watt Dual Channel Amplifier with 50 Watt Backup
ECS-CE4	4 Zone Splitter
ECS-LOC	Local Operator Console (15 max.)
6815	Signaling Line Circuit Expander (SLC) Module
5824	Printer Interface Module
RA-2000	LCD Remote Annunciator
5865-3	LED Remote Annunciator
5865-4	LED Remote Annunciator with reset and silence switches
5880	LED I/O module
RPS-1000	Intelligent Distributed Power Module
5496	Intelligent Distributed Power Module

2. The FACP shall support the operation of 159 detectors and 159 addressable modules per SLC loop without regard to device type.

The following devices shall be supported:

IDP-PHOTO	Addressable Photoelectric Smoke detector
IDP-PHOTO-T	Addressable Photoelectric Smoke detector with Thermal
IDP-PHOTOR	Addressable Photoelectric Smoke detector with Relay
IDP-FIRE-CO	Addressable Combination Photoelectric and CO Detector
IDP-HEAT	Addressable Heat Sensor
IDP-HEAT-ROR	Addressable Heat with Rate of Rise
IDP-HEAT-HT	Addressable Heat High temp 190°
IDP-ACCLIMATE	Addressable Multi Criteria Smoke detector with thermal
IDP-6AB	6" detector base
DNR	Addressable Duct Detector Housing
IDP-RELAY	Addressable Relay Module
IDP-RELAY-6	Addressable Multi Relay Module
IDP-RELAYMON-2	Addressable Relay/Input Module
IDP-MONITOR	Addressable Input Module (Class A or B)
IDP-MINIMON	Mini Input Module
IDP-MONITOR-2	Addressable Dual Input Module

IDP-MONITOR-10	Addressable Multi Input Module (10)
IDP-CONTROL	Addressable Notification Module
IDP-CONTORL-6	Addressable Notification Multi Module (6)
IDP-ZONE	Two Wire Smoke Detector Module
IDP-ZONE-6	6 Multi Smoke Detector Module
IDP-ISO	Isolation Module
IDP-BEAM	Addressable Beam Detector
IDP-BEAM-T	Addressable Beam Detector with Test feature
B224BI	Addressable Isolator base
B224RB	Detector Relay Base
B200S	Intelligent Detector Sounder Base
B200S-LF	Intelligent Detector Low Frequency Sounder Base
RTS151KEY	Remote Test Switch for Photoelectric Duct Detector
RTS151	Remote Test Switch for Photoelectric Duct Detector
IDP-Pull-SA	Addressable Single Action Pull Station
IDP-Pull-DA	Addressable Dual Action Pull Station
ISO-6	6 Multi Isolation Module

OR

SK-PHOTO	Addressable Photoelectric Smoke detector
SK-PHOTO-T	Addressable Photoelectric Smoke detector with Thermal
SK -PHOTOR	Addressable Photoelectric Smoke detector with Relay
SK -FIRE-CO	Addressable Combination Photoelectric and CO Detector
SK -HEAT	Addressable Heat Sensor
SK -HEAT-ROR	Addressable Heat with Rate of Rise
SK -HEAT-HT	Addressable Heat High temp 190°
SK -ACCLIMATE	Addressable Multi Criteria Smoke detector with thermal
SK -6AB	6" detector base
SK-DUCT	Addressable Duct Detector Housing
SK -RELAY	Addressable Relay Module
SK -RELAY-6	Addressable Multi Relay Module
SK -RELAYMON-2	Addressable Relay/Input Module
SK -MONITOR	Addressable Input Module (Class A or B)
SK -MINIMON	Mini Input Module
SK -MONITOR-2	Addressable Dual Input Module
SK -MON-10	Addressable Multi Input Module (10)
SK-CONTROL	Addressable Notification Module
SK -CONTORL-6	Addressable Notification Multi Module (6)
SK -ZONE	Two Wire Smoke Detector Module
SK -ZONE-6	6 Multi Smoke Detector Module
SK -ISO	Isolation Module
SK -BEAM	Addressable Beam Detector
SK -BEAM-T	Addressable Beam Detector with Test feature
B224BI	Addressable Isolator base
B224RB	Detector Relay Base
B200S	Intelligent Detector Sounder Base
B200S-LF	Intelligent Detector Low Frequency Sounder Base
RTS151KEY	Remote Test Switch for Photoelectric Duct Detector
RTS151	Remote Test Switch for Photoelectric Duct Detector
SK -Pull-SA	Addressable Single Action Pull Station
SK -Pull-DA	Addressable Dual Action Pull Station

The FACP shall support these other Honeywell devices via addressable input, addressable notification, or addressable output modules.

PS-DALOB	Dual Action Manual Pull Outdoor Listed
PS-DAH	Dual Action Manual Pull Hex Key reset
PS-SATK	Single Action Manual Pull Station – Key Reset
PS-DATK	Dual action Manual Pull Station – Key Reset
PS-DASP	Dual action Manual Pull Station “Spanish”- Key reset
SB-I/O	Surface mount back box for outdoor use.

2.5 FURNISH AND INSTALL, WHERE SHOWN ON THE DRAWINGS, THE FOLLOWING DEVICES

A. Manual Fire Alarm Stations

1. Manual fire alarm stations shall be non-coded, break glass, single or double action type, with a key operated test-reset lock in order that they may be tested, and so designed that after actual emergency operation, they cannot be restored to normal except by use of a key. The reset key shall be so designed that it will reset manual station and open FACP without use of another key. An operated station shall automatically condition itself so as to be visually detected, as operated, at a minimum distance of fifty feet, front or side. Manual stations shall be constructed of die cast metal or polycarbonate with clearly visible operating instructions on the front of the stations in raised letters. Stations shall be suitable for surface mounting on matching backbox, or semi-flush mounting on a standard single-gang box, and shall be installed within the limits defined by the Americans with Disabilities Act (ADA) dependent on manual station accessibility or per local requirements. Manual stations shall be addressable models IDP-PULL-DA / IDP-PULL-SA or SK-PULL-DA / SK-PULL-SA or installed in conjunction with an addressable input module, IDP-MONITOR / IDP-MINIMON or SK-MONITOR / SK-MINIMON. Manual stations shall be Honeywell Underwriters Laboratories listed.

B. Remote Power Supplies

1. The remote power supplies for notification appliances shall be the Model RPS-1000 or 5496. The Model RPS-1000 intelligent power supply shall wire on the main SBUS and be programmed through the IFP-300ECS. It will support 6 amps of 24 volt DC power with 6 Flexput™ circuits, rated at 3 amps each. Two additional 6815 SLC loop expanders shall be capable of be install in the cabinet. The power supply will also regenerate the SBUS for an additional 6000 feet of SBUS capability.
2. The Silent Knight 5496 intelligent power supply shall wire on the main SBUS and be programmed through the IFP-300ECS. It will support 6 amps of 24 volt DC power with 4 notification circuits, rated at 3 amps each.
3. The remote power supply model 5499 or 5495 may also be used on the system. These power supplies are activated by a notification circuit or an IDP-Control module and support 6 or 9 amps of 24VDC power, with 4 notification circuits, rated at 3 amps each.

C. Notification Devices

1. The visible and audible/visible signal shall be System Sensor series signal devices and be listed by Underwriters Laboratories Inc. per UL 1971 and/or 1638 and UL 464. The notification appliance (combination audible/visible units only) shall produce a peak sound output of 90dba or greater as measured in an anechoic chamber. The signaling appliance shall also have the capability to silence the audible signal while leaving the visible signal energized with the use of a single pair of wires. Additionally, the user shall be able to select either continuous or temporal tone output with the temporal signal having the ability to be synchronized. The visible signaling appliance shall maintain a minimum flash rate of 1Hz or greater regardless of power input voltage. The appliance shall also be capable of meeting the candela requirements of the blueprints presented by the engineer and ADA. The appliance shall be polarized to allow for electrical supervision of the system wiring. The unit shall be provided with terminals with barriers

for input/output wiring and be able to mount to a single gang or double gang box or double workbox with the use of an adapter plate. The unit shall have an input voltage range of 20-30 volts with either direct current or full wave rectified power.

D. Smoke Detectors

1. Smoke detectors shall be Honeywell Farenhyt Series Model IDP-PHOTO or SK-PHOTO, analog/addressable photoelectric smoke detectors. The combination detector head and twist lock base shall be U.L. listed compatible with the Honeywell IFP-300ECS fire alarm control panel. The base shall permit direct interchange with Honeywell's IDP-ACCLIMATE / IDP-HEAT detectors or SK-ACCLIMATE / SK-HEAT detectors. The base shall be the appropriate twist lock base B210LP. The smoke detector shall have a flashing status LED for visual supervision. When the detector is actuated, the flashing LED will latch on steady at full brilliance. The detector may be reset by actuating the control panel's reset switch. The sensitivity of the detector shall be capable of being selected and measured by the control panel without the need for external test equipment. The vandal security-locking feature shall be used in those areas as indicated on the drawing. The locking feature shall be field selectable when required. It shall be possible to perform a sensitivity test of the detector without the need of generating smoke. The test method shall simulate the effects of products of combustion in the chamber to ensure testing of the detector circuits. Detectors shall have completely closed back to restrict entry of dust and air turbulence and have a 30 mesh insect screen. Electronics of the unit shall be shielded to protect against false alarms from E.M.I. and R.F.I.

E. Heat Detectors

1. Furnish and install analog/addressable heat detectors, Honeywell model IDP-HEAT or SK-HEAT. The combination heat detector and twist lock base shall be U.L. listed compatible with the Honeywell IFP-300ECS fire alarm control panel. The base shall permit direct interchange with the Honeywell Farenhyt Series IDP-PHOTO / IDP-ACCLIMATE or SK-PHOTO / SK-ACCLIMATE detectors. The base shall be appropriate twist lock base B210LP. The heat detector shall have a flashing status LED for visual supervision. When the detector is actuated, the flashing LED will latch on steady at full brilliance. The detector may be reset by actuating the control panel's reset switch. The vandal security-locking feature shall be used in those areas as indicated on the drawings. Electronics of the unit shall be shielded to protect against false alarms from E.M.I. and R.F.I.

F. Duct Detectors

Duct Detector shall be Honeywell Farenhyt Series Model DNR Duct Detector Housing. A separate IDP-PHOTO / IDP-PHOTOR or SK-PHOTO / SK-PHOTOR is required. The duct detector housing shall be capable of housing the IDP-RELAY or SK-RELAY module for optional output devices. Provide remote test station for each duct detector.

2.6 WIRING

A. Installer's Responsibilities

1. The installer shall coordinate the installation of the fire alarm equipment. All conductors and wiring shall be installed according to the manufacturer's recommendations.
2. It shall be the installer's responsibility to coordinate with the supplier, regarding the correct wiring procedures before installing any conduits or conductors.

B. Installation of System Components

1. System components shall be installed in accordance with the latest revisions of the appropriate NFPA pamphlets, the requirements contained herein, National Electrical Code, local and state regulations, the requirements of the fire department and other applicable authorities having jurisdiction (AHJ).
2. All wire used on the fire alarm system shall be U.L. Listed as fire alarm protection signaling circuit cable per National Electrical Code, Articles 760.

PART 3 – EXECUTION

3.1 General

1. The contractor shall warrant all equipment and wiring free from inherent mechanical and electrical defects for one year (365 days) from the date of final acceptance.

3.2 Final Test

1. Before the installation shall be considered completed and acceptable by the awarding authority, a test of the system shall be performed as follows:
 - The contractor's job foreman, a representative of the owner, and the fire department shall operate every building fire alarm device to ensure proper operation and correct annunciation at the control panel.
 - At least one half of all tests shall be performed on battery standby power.
 - Where application of heat would destroy any detector, it may be manually activated.
 - The communication loops and the indicating appliance circuits shall be opened in at least two (2) locations per circuit to check for the presence of correct supervision circuitry.
2. When the testing has been completed to the satisfaction of both the contractor's job foreman and owner, a notarized letter cosigned by each attesting to the satisfactory completion of said testing shall be forwarded to the owner and the fire department.
3. The contractor shall leave the fire alarm system in proper working order, and, without additional expense to the owner, shall replace any defective materials or equipment provided by him under this contract within one year (365 days) from the date of final acceptance by the awarding authority.
4. Prior to final test the fire department must be notified in accordance with local requirements.

3.3 As Built Drawings, Testing, and Maintenance Instructions

A. As Built Drawings

1. A complete set of reproducible "as-built" drawings showing installed wiring, color coding, and wire tag notations for exact locations of all installed equipment, specific interconnections between all equipment, and internal wiring of the equipment shall be delivered to the owner upon completion of system.

B. Operating and Instruction Manuals

1. Operating and instruction manuals shall be submitted prior to testing of the system. Three (3) complete sets of operating and instruction manuals shall be delivered to the owner upon completion. User operating instructions shall be provided prominently displayed on a separate sheet located next to the control unit in accordance with U.L. Standard 864.

END OF SECTION 284600

SECTION 311000

SITE CLEARING

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. Protecting existing vegetation to remain.
 - 2. Removing existing vegetation.
 - 3. Clearing and grubbing.
 - 4. Stripping and stockpiling topsoil.
 - 5. Stripping and stockpiling rock.
 - 6. Removing above- and below-grade site improvements.
 - 7. Disconnecting, capping or sealing, and removing site utilities, abandoning site utilities in place.
 - 8. Temporary erosion and sedimentation control.

- B. Related Requirements:

- 1. Section 312000 – "Earth Moving" for the moving of site soils.
 - 2. Section 312500 – "Erosion and Sediment Control" for the protection of site soils during construction from stormwater erosion and damage.

1.4 DEFINITIONS

- A. Subsoil: Soil beneath the level of sub grade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.
- C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow.

- D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally 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 larger than 2 inches in diameter; and free of weeds, roots, toxic materials, or other non-soil materials.
- E. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.
- F. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on Drawings
- G. Vegetation: Trees, shrubs, ground covers, grass, and other plants.

1.5 PREINSTALLATION MEETINGS

- A. Coordination: Conduct conference at building 237.

1.6 MATERIAL OWNERSHIP

- A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.7 INFORMATIONAL SUBMITTALS

- A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes reconstruction conditions that might be misconstrued as damage caused by site clearing.
 - 1. Use sufficiently detailed photographs or video recordings.
 - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.
- B. Topsoil stripping and stockpiling program.
- C. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.8 QUALITY ASSURANCE

- A. Topsoil Stripping and Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

1.9 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises.
- C. Utility Locator Service: Notify Pennsylvania One Call for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place.
- E. Tree- and Plant-Protection Zones: Protect according to requirements in Section 015639 "Temporary Tree and Plant Protection."
- F. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."
1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Protect existing site improvements to remain from damage during construction.
1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
- B. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

- C. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.
- D. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
 - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer to a density equal to adjacent original ground.

3.3 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to depth indicated on Drawings in a manner to prevent intermingling with underlying subsoil or other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
 - 1. Limit height of topsoil stockpiles to 72 inches.
 - 2. Do not stockpile topsoil within protection zones.
 - 3. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.4 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
 - 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
 - 2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.5 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
- B. Separate recyclable materials produced during site clearing from other non recyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000

SECTION 312000

EARTH MOVING

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. Excavating and filling for rough grading the Site.
2. Testing for contaminated soils.
3. Preparing subgrades for walks, pavements and plants.
4. Excavating and backfilling for buildings and structures.
5. Drainage course for concrete slabs-on-grade.
6. Subbase course for concrete walks and pavements.
7. Subsurface drainage backfill for trenches.
8. Excavating and backfilling trenches for utilities and pits for buried utility structures.

- B. Related Requirements:

1. Section 311000 "Site Clearing" for site stripping, grubbing, stripping topsoil, and removal of above- and below-grade improvements and utilities.
2. Section 312216 "Fine Grading" for site grading and earth moving adjustment.
3. Section 312500 "Erosion and Sediment Control" for site and soil stabilization during construction.
4. Section 329113 "Soil Preparation" for soil information used for the site.
5. Section 329200 "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.

1.4 BASIS OF DESIGN

- 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.

1.5 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 soil contamination, 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. Prime contractor to be responsible for contamination testing, removing, replacing, and disposing of any contaminated soil on site.
- 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. 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.

- H. Earthwork specifications shall stipulate that surface water and ground water should be prevented from entering excavations, from ponding on prepared subgrades and from flooding Project site and surrounding area. Earthwork specifications shall also stipulate that 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.

1.7 COORDINATION

- A. Each Prime Contractor shall be responsible for providing all trenching, excavation, filling, backfilling, and concrete work required by their respective contract work, and shall comply with the requirements of the applicable specification sections of Division 3 and Division 31 for same.

1.8 UNIT PRICES

- A. Work of this Section is affected by unit prices for earth moving specified in Section 010250 "Unit Prices in Lump Sum Contracts."

1.9 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
 - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.
- C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
 - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
 - 2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
 - 3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.
- G. Fill: Soil materials used to raise existing grades.
- H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by a geotechnical testing agency, according to ASTM D1586.

- I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- J. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- K. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
- L. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.10 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct pre-excavation conference at Building 237.
 - 1. Review methods and procedures related to earthmoving, including, but not limited to, the following:
 - a. Personnel and equipment needed to make progress and avoid delays.
 - b. Coordination of Work with utility locator service.
 - c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
 - d. Extent of trenching by hand or with air spade.
 - e. Field quality control.

1.11 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:
 - 1. Classification according to ASTM D2487.
 - 2. Laboratory compaction curve according to ASTM D698
- C. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. Submit before earth moving begins.

1.12 QUALITY ASSURANCE

1.13 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
 1. Do not proceed with work on adjoining property until directed by Architect.
- C. Utility Locator Service: Notify Pennsylvania One Call for area where Project is located before beginning earth-moving operations.
- D. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified Section 311000 "Site Clearing" are in place.
- E. 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.
- F. Do not direct vehicle or equipment exhaust towards protection zones.
- G. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrowed soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D2487 or a combination of these groups; free of rock or gravel larger than [3 inches] in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487 or a combination of these groups.
 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Sub-base Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

- F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
- H. Drainage Course: Narrowly graded mixture of washed crushed stone or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and zero to 5 percent passing a No. 8 sieve.
- I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and zero to 5 percent passing a No. 4 sieve.
- J. Sand: ASTM C33/C33M; fine aggregate.
- K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

- A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
 - 1. Survivability: Class 2; AASHTO M 288.
 - 2. Apparent Opening Size: No. 40 sieve, maximum; ASTM D4751.
 - 3. Permittivity: 0.2 per second, minimum; ASTM D4491.
 - 4. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.

2.3 CONTROLLED LOW-STRENGTH MATERIAL

- A. Controlled Low-Strength Material: Self-compacting, low-density, flowable concrete material produced from the following:
 - 1. Portland Cement: ASTM C150/C150M, Type I.
 - 2. Fly Ash: ASTM C618, Class C or F.
 - 3. Normal-Weight Aggregate: ASTM C33/C33M, 3/4-inch nominal maximum aggregate size.
 - 4. Water: ASTM C94/C94M.
- B. Produce conventional-weight, controlled low-strength material with 80-psi compressive strength when tested according to ASTM C495/C495M.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.
- B. Protect and maintain erosion and sedimentation controls during earth-moving operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

- A. Provide dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
- B. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
 - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
- D. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

3.3 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
- B. Excavations at Edges of Tree- and Plant-Protection Zones:
 - 1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
 - 2. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.4 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.5 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicate gradients, lines, depths, and elevations.
 - 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
 - 1. Clearance: As indicated.
- C. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.
 - 1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
- D. Trenches in Tree- and Plant-Protection Zones:
 - 1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
 - 2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
 - 3. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.6 EXCAVATION FOR ELEVATOR CYLINDER – N/A

3.7 SUBGRADE INSPECTION

- A. Notify Architect when excavations have reached required subgrade.
- B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices
- D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.8 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.
 - 1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.9 STORAGE OF SOIL MATERIALS

- A. Stockpile borrowed soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
- B. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.10 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
 - 1. Construction below finish grade including, where applicable, subdrainage, damp proofing, waterproofing, and perimeter insulation.
 - 2. Surveying locations of underground utilities for Record Documents.
 - 3. Testing and inspecting underground utilities.
 - 4. Removing concrete formwork.
 - 5. Removing trash and debris.
 - 6. Removing temporary shoring, bracing, and sheeting.
 - 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.11 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 033000 "Cast-in-Place Concrete."
- D. Trenches under Roadways: Provide 6-inch thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches Concrete is specified in Section 033000 "Cast-in-Place Concrete."
- E. Backfill voids with satisfactory soil while removing shoring and bracing.
- F. Initial Backfill:

1. Soil Backfill: Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
 - a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
2. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.

G. Final Backfill:

1. Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.

H. Warning Tape: Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.12 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
 1. Under grass and planted areas, use satisfactory soil material.
 2. Under walks and pavements, use satisfactory soil material.
 3. Under steps and ramps, use engineered fill.
 4. Under building slabs, use engineered fill.
 5. Under footings and foundations, use engineered fill.
- C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.13 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
 2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.14 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D698
 - 1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
 - 2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
 - 3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
 - 4. For utility trenches, compact each layer of initial and final backfill soil material at [85] percent.

3.15 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
 - 1. Provide a smooth transition between adjacent existing grades and new grades.
 - 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:
 - 1. Turf or Unpaved Areas: Plus or minus 1 inch
 - 2. Walks: Plus or minus 1 inch
 - 3. Pavements: Plus or minus 1/2 inch
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.16 SUBSURFACE DRAINAGE

- A. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
 - 1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D698 with a minimum of two passes of a plate-type vibratory compactor.
 - 2. Place and compact impervious fill over drainage backfill in 6-inch- thick compacted layers to final subgrade.

3.17 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

- A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Shape subbase course and base course to required crown elevations and cross-slope grades.
2. Place subbase course and base course 6 inches or less in compacted thickness in a single layer.
3. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
4. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D698

3.18 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

- A. Place drainage subbase course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
 1. Place drainage course 6 inches or less in compacted thickness in a single layer.
 2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D698.

3.19 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- C. Testing agency will test compaction of soils in place according to ASTM D1556, ASTM D2167, ASTM D2937, and ASTM D6938, as applicable. Tests will be performed at the following locations and frequencies:
 1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab but in no case fewer than three tests.
 2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet (or less of wall length but no fewer than two tests.
 3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length but no fewer than two tests.
- D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.20 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
 - 1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.21 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000

SECTION 312216
FINE GRADING

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. Work Included in this section:
- a Finish grade sub-grade.
 - b Place, level, and compact topsoil.
- B. RELATED WORK
- a Section 312000 – Earth Moving
 - b Section 329113 – Soil Preparation
 - c Section 329200 – Turf and Grasses

1.4 SAMPLES

- A. Submit sample of imported fill to testing laboratory, in air-tight containers.
- B. Disregard sample submission if recent test results are available for type of fill.

1.5 PROTECTION

- A. Protect landscaping and other features remaining as final work.
- B. Protect existing structures, fences, roads, sidewalks, paving and curbs.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Topsoil: Reuse from stockpile and provide new topsoil as needed.
- B. Imported Topsoil: friable loam, typical of cultivated topsoils locally; free of subsoil, roots, grass, excessive amount of weeds, stone, and foreign matter; acidity range (pH) of 6.0 to 7.0; containing a minimum of 2 percent and a maximum of 5 percent organic matter. Topsoil shall not be delivered or used for planting while in a frozen or muddy condition. Topsoil shall conform to the following grain size distribution for material passing the #10 sieve:

<u>U.S. Sieve Size Number</u>	<u>Percent Passing</u>	
	<u>Minimum</u>	<u>Maximum</u>
10 100 -- 18	85	100
35	70	95
60	50	85
140	36	63
270	32	52
0.002mm	3	8

PART 3 - EXECUTION

3.1 INSPECTION

- A. Verify site conditions and note irregularities affecting work of this Section.
- B. Beginning work of this Section means acceptance of existing conditions.

3.2 SUBGRADE PREPARATION

- A. Eliminate uneven areas and low spots. Remove debris, roots, branches, stones, in excess of 1 inch in size. Remove sub-grade contaminated with petroleum products.
- B. Scarify sub-grade to depth of 6 inches where topsoil is scheduled. Remove debris that is brought to the surface in excess of 1 inch in size.
- C. Review sub-grade scarification with Owner's Representative prior to commencing placement of topsoil.

3.3 PLACING TOPSOIL

- A. Place topsoil in areas where planting is scheduled and as noted on plans.
- B. Use topsoil in relatively dry state. Place during dry weather.
- C. Fine grade topsoil eliminating rough or low areas. Maintain levels, profiles, and contours of subgrade.
- D. Remove stone, roots, grass, weeds, debris, and foreign material while spreading.
- E. Manually spread topsoil around trees, plants, and structures, to prevent damage.
- F. Lightly compact placed topsoil.
- G. Remove surplus subsoil and topsoil from site.
- H. Leave stockpile area and site clean and raked, ready to receive landscaping.

3.4 TOLERANCES

- A. Top of Topsoil: Plus or minus 1/2 inch.

3.5 SCHEDULE OF LOCATIONS

- A. The following paragraphs identify compacted topsoil thickness for various locations.
 - 1. Lawn Areas: 6 inches.
 - 2. Planting Beds (shrubs, groundcover, etc.): 12 inches. Includes all beds at grade.
 - 3. Planters: To within 3 inches of rim or top of wall.

END OF SECTION 312216

SECTION 312500

SOIL EROSION & SEDIMENT CONTROL

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 SCOPE OF WORK

- A. The work of this Section includes all temporary erosion and sediment control and related and incidental operations, including:

- 1. Compost filter sock

1.03 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.04 SUBMITTALS

- A. Submit complete shop drawings and product information for all items to be furnished under this Section upon receipt of notice to proceed and prior to construction.

1.05 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary trades and who are completely familiar with the specified requirements and methods needed for proper performance of the work of this Section.
- B. Codes and Standards: Perform work in compliance with applicable requirements of governing authorities having jurisdiction. Construction operations shall be carried out in a manner such that soil erosion, air pollution, and water pollution is minimized. State, County, and Municipal laws concerning pollution abatement shall be followed.
- C. The recommendations and Standards set forth in Chapter 102 of the Pennsylvania Code (Erosion and Sediment Control Handbook), published by the PA Department of Environmental Protection (PADEP), shall be applicable where the work is not specifically detailed in this Specification, the accompanying Drawings, or the Erosion and Sediment Control Plan.
- D. The Contractor shall take action to remedy unforeseen erosion conditions and to prevent damage to adjacent properties as a result of increased runoff and/or sediment displacement. Stockpiles of wood chips, hay bales, crushed stone, and other mulches shall be held in readiness to deal immediately with emergency problems of erosion. All erosion control checks and structures shall be inspected after heavy rainfalls, and if damaged, repaired or replaced.

- E. No other construction activities may take place until appropriate Erosion and Sedimentation Control devices have been installed and approved by Owner/Authorized Representative. All changes to the Erosion and Sedimentation Control Plan must be approved by Owner/Authorized Representative prior to implementation.

1.06 REFERENCES

- A. PennDOT, Publication 408/2020 Specifications.
- B. Pennsylvania Department of Environmental Protection, Erosion and Sediment Pollution Control Program Manual (most recent version).
- C. Commonwealth of Pennsylvania, Department of Transportation (PennDOT)
 - 1. Bulletin No. 15: Approved Construction Materials.

PART 2 - PRODUCTS

2.01 COMPOST FILTER SOCK

- A. Compost filter socks shall be a three-dimensional tubular sediment control listed in PennDOT Bulletin 15 or approved equal.
- A. Pumped water filter bags shall be provided in accordance with PennDOT Publication 408, Section 855.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

- A. All temporary erosion and sediment control measures specified herein shall be in place before the beginning of any earthwork or excavation.
- B. All erosion and sediment control devices shall be installed according to the manufacturer's specifications or PennDOT Publication 408 Specifications.
- C. When temporary erosion and sediment control measures as described herein do not provide adequate control, replacement or relocation of measures may be required as directed by the owner/Authorized Representative.
- D. Erosion and sediment control measures shall be inspected weekly and after every precipitation event.
- E. Contractor shall maintain complete written logs of inspections and shall make them available to PWD Inspector/Owner/Engineer upon request.
- F. All maintenance work, including but not limited to cleaning, repair, replacement, regrading, and restabilization of temporary erosion and sediment control measures shall be performed immediately.
- G. Contractor shall ensure that erosion and sedimentation control measures remain in place and fully functional until site achieves final stabilization.

3.04 STORAGE STOCKPLIES

- A. Stockpiles of all loose materials (aggregate, fill, soils, etc) shall be protected from dust and rain by use of a cover. The cover shall be free of defects and secured adequately to

maintain protection of the materials. Owner/Authorized Representative reserves the right to refuse use of any material that has been compromised by inadequate protection onsite.

- B. Stockpiles shall not be placed upslope from any infiltration structure. Any drainage structure (such as but not exclusively inlets) downslope of a stockpile shall be adequately protected from runoff.
- C. Stockpile heights are not to exceed 35 feet. Stockpile slopes shall be 2:1 or flatter.

3.05 REMOVAL AND FINAL CLEANUP

- A. Once the site has been fully stabilized and approval is given by Owner/Authorized Representative, temporary erosion and sedimentation control measures and all accumulated silt and sediment shall be removed. All permanent inlet protection measures shall be cleaned, inspected, and verified to be in working order.
- B. Any remaining dirt or debris within the public right of way shall be removed by the Contractor, using necessary means as sufficient to remove the dirt and debris from the public right of way. This may include, but is not limited to, street sweeping, sidewalk vacuuming, inlet cleaning, power washing, or hand removal.
- C. Silt and waste materials shall be disposed of in a proper manner. No extra construction materials are to remain onsite upon completion of the Work. The Work of this Contract shall not be considered complete until all extraneous construction-related items have been removed (temporary traffic control devices, signage, etc).

END OF SECTION 312500

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.
- B. This Section includes hot-mix asphalt paving and patching.

1.2 SUMMARY

- A. Section Includes:
 - 1. Hot-mix asphalt paving.
 - 2. Hot-mix asphalt overlay.
 - 3. Cold milling of existing asphalt pavement.
 - 4. Hot-mix asphalt patching.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
- B. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
- C. Material certificates.

1.4 QUALITY ASSURANCE

- A. Testing: Section 014000 Quality Control Testing Services and Section 014010 – Quality Assurance Testing and Inspection Services for additional information.
- B. Manufacturer Qualifications: Manufacturer shall be registered with and approved by the Pennsylvania department of transportation (PENNDOT).
- C. Regulatory Requirements: Comply with the Pennsylvania Standard Specifications for Highway Construction, latest edition, hereafter referred as Standard Pavement Specifications for asphalt paving work.
- D. Asphalt-Paving Publication: Comply with AI MS-22, "Construction of Hot Mix Asphalt Pavements," unless more stringent requirements are indicated.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:
 - 1. Prime and Tack Coat: Minimum surface temperature of 60 deg F.
 - 2. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
 - 3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.
- B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials, 50 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 AGGREGATES

- A. Coarse Aggregate: All coarse aggregate shall consist of sound, durable rock, free from cemented lumps or objectionable coatings, all meeting the quality requirements of the Pennsylvania Standard Specifications for Highway Construction, latest edition.
- B. Fine Aggregate: Fine aggregate for asphaltic concrete shall be a fine, granular material manufactured by the mechanical reduction of sound, durable rock with a percentage of wear not exceeding 50 when tested in accordance with AASHTO T 96, and meeting Sec 703.1, except the gradation of the No. 4 sieve shall be modified to 70- 100 percent passing.

2.2 ASPHALT MATERIALS

- A. Asphalt Binder: This material shall be homogeneous and free from water, and shall not, on heating, foam below the specified minimum flash point. The material shall be prepared by refining crude petroleum by suitable methods. The material shall conform to the requirements of Sec 702.
- B. Tack Coat: All material shall conform to Division 1000, Materials Details, and specifically as follows: Emulsified Asphalt (SS 1, SS- IH, CSS- 1, or CSS- IH) Section 1015.7
- C. Prime Coat: All material shall conform to Division 1000, Materials Details, and specifically as follows:

Item	Section
Type RC Liquid.	1015.2
Type MC Liquid Asphalt.	1015.3
Emulsified Asphalt	1015.7

2.3 AUXILIARY MATERIALS

- A. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with FS TT-P-115, Type I or AASHTO M 248, Type N.
 - 1. Color: White, Yellow.

- B. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, with drying time of less than 45 minutes.
 - 1. Color: White, Yellow.
- C. Joint Sealant: ASTM D 3405 or AASHTO M 301, hot-applied, single-component, polymer-modified bituminous sealant.

2.4 MIXES

- A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes in accordance with Commonwealth of Pennsylvania department of transportation Publication 408/2020 specifications and complying with the following requirements:
 - 1. Provide mixes with a history of satisfactory performance in the geographical area where Project is located.
 - 2. Base Course: Type "BP- 1" Bituminous Pavement, complying with the requirements of Sec 300 of PENNDOT Standard Specifications, latest edition.
 - 3. Wedge and Leveling Courses: Type "BP-2" Bituminous Pavement, complying with the requirements of Sec 400 of PENNDOT Standard Specifications, latest specifications.
 - 4. Surface Course: Type "BP-2" Bituminous Pavement, complying with the requirements of PENNDOT Standard Specifications, latest edition, for:
 - a. Roadways, Parking Lots, and Bike Paths.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

- A. Ensure that prepared subgrade is ready to receive paving. Immediately before placing asphalt materials, remove loose and deleterious materials from substrate surfaces.
- B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.
- C. Prime Coat: Apply uniformly to the width of the section to be primed at a rate of 0.2 and 0.5 gallons per square yard.
 - 1. Allow prime coat to cure 12 hours undisturbed before applying hot-mix asphalt paving
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- D. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
 - 1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.
- E. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.10 gal./sq. yd.
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.

2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.2 COLD MILLING

- A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.
 1. Mill to a depth of 3 inches (75 mm).
 2. Mill to a uniform finished surface free of excessive gouges, grooves, and ridges.
 3. Control rate of milling to prevent tearing of existing asphalt course.
 4. Repair or replace curbs, driveway aprons, manholes, and other construction damaged during cold milling.
 5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
 6. Patch surface depressions deeper than 1 inch (25 mm) after milling, before wearing course is laid.
 7. Handle milled asphalt material in accordance with approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."
 8. Keep milled pavement surface free of loose material and dust.
 9. Do not allow milled materials to accumulate on-site.

3.3 PATCHING

- A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Re-compact existing unbound-aggregate base course to form new subgrade.
- B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.10 gal./sq. yd.
- C. Patching: Fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact flush with adjacent surface.

3.4 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
 1. Spread mix at minimum temperature of 250 deg F.
 2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.5 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.
 - 1. Complete compaction before mix temperature cools to 185 deg F.
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
 - 1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- F. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.6 INSTALLATION TOLERANCES

- A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 - 1. Base Course: Plus or minus 1/2 inch.
 - 2. Surface Course: Plus 1/4 inch, no minus.
- B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
 - 1. Base Course: 1/4 inch.
 - 2. Surface Course: 1/8 inch.

3.7 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with the Owners Representative.
- B. Allow paving to age for 30 days before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.

- D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, crisp, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

- 1. Broadcast glass spheres uniformly into wet pavement markings at a rate of 6 lb/gal.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports. All testing requirements shall be per PennDOT standard specifications.
- B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.9 DISPOSAL

- A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

END OF SECTION 321216

SECTION 321313
CONCRETE PAVING

PART 1 GENERAL

1. STIPULATIONS

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

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.

3. SUMMARY

- a. Section Includes Concrete Paving, Including the Following:
 - 1) Driveways.
 - 2) Roadways.
 - 3) Parking lots.
 - 4) Curbs and gutters.
 - 5) Walkways.
- b. Related Requirements:
 - 1) Section 321216 "Asphalt Paving" for asphalt paving.
 - 2) Section 014000 Quality Control Testing Services and Section 014010 – Quality Assurance Testing and Inspection Services.

4. DEFINITIONS

- a. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.
- b. W/C Ratio: The ratio by weight of water to cementitious materials.

5. PREINSTALLATION MEETINGS

- a. Preinstallation Conference: Conduct conference at Building 237 at Biddle Air Guard Station

- 1) Review methods and procedures related to concrete paving, including but not limited to, the following:
 - a) Concrete mixture design.
 - b) Quality control of concrete materials and concrete paving construction practices.
- 2) Require representatives of each entity directly concerned with concrete paving 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 paving Subcontractor.
 - e) Manufacturer's representative of stamped concrete paving system used for stamped detectable warnings.

6. ACTION SUBMITTALS

- a. Product Data: For each type of product.
- b. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.
- c. Samples for Verification: For each type of product or exposed finish, prepared as Samples of size indicated below:
 - 1) Exposed Aggregate: 10-lb Sample of each mix.
- d. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

7. INFORMATIONAL SUBMITTALS

- a. Qualification Data: For qualified Installer of stamped detectable warnings, ready-mix concrete manufacturer and testing agency.
- b. Material Certificates: For the following, from manufacturer:
 - 1) Cementitious materials.
 - 2) Steel reinforcement and reinforcement accessories.
 - 3) Fiber reinforcement.
 - 4) Admixtures.
 - 5) Curing compounds.
 - 6) Applied finish materials.
 - 7) Bonding agent or epoxy adhesive.

- 8) Joint fillers.
- c. Material Test Reports: For each of the following:
 - 1) Aggregates - Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
- d. Field quality-control reports.

8. QUALITY ASSURANCE

- a. Ready-Mix-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 according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").
- b. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.
 - 1) Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- c. 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 concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship.
 - 2) Build mockups of concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Architect and not less than 96 inches by 96 inches. Include full-size detectable warning.
 - 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) Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- d. Penalty for accepted under-strength concrete:
 - 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 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 one 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.

9. PRECONSTRUCTION TESTING

- a. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

10. FIELD 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, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F 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 and as follows when hot-weather conditions exist:
 - 1) Cool ingredients before mixing to maintain concrete temperature below 90 deg F 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.

PART 2 PRODUCTS

1. CONCRETE, GENERAL

- a. ACI Publications: Comply with ACI 301 unless otherwise indicated.

2. 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 with 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.
3. STEEL REINFORCEMENT
- a. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, fabricated from as-drawn steel wire into flat sheets.
 - b. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.
 - c. Epoxy-Coated Welded-Wire Reinforcement: ASTM A884/A884M, Class A, plain steel.
 - d. Reinforcing Bars: ASTM A615/A615M, Grade 60; deformed.
 - e. Galvanized Reinforcing Bars: ASTM A767/A767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A615/A615M, Grade 60 deformed bars.
 - f. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M or ASTM A934/A934M; with ASTM A615/A615M, Grade 60 deformed bars.
 - g. Steel Bar Mats: ASTM A184/A184M; with ASTM A615/A615M, Grade 60 deformed bars; assembled with clips.
 - h. Plain-Steel Wire: ASTM A1064/A1064M, as drawn
 - i. Deformed-Steel Wire: ASTM A1064/A1064M.
 - j. Epoxy-Coated-Steel Wire: ASTM A884/A884M, Class A; coated, plain
 - k. Joint Dowel Bars: ASTM A615/A615M, Grade 60 plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A767/A767M, Class I coating. Cut bars true to length with ends square and free of burrs.
 - l. Epoxy-Coated, Joint Dowel Bars: ASTM A775/A775M; with ASTM A615/A615M, Grade 60 plain-steel bars.
 - m. Tie Bars: ASTM A615/A615M, Grade 60; deformed.
 - n. Hook Bolts:(ASTM F568M, Property Class 4.6), internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.
 - o. 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) For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
- p. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.
- q. Zinc Repair Material: ASTM A780/A780M.

4. CONCRETE MATERIALS

- a. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:
- 1) Portland Cement: ASTM C150/C150M, white Portland cement Type I.
 - 2) Fly Ash: ASTM C618, Class C.
 - 3) Slag Cement: ASTM C989/C989M, Grade 100 or 120.
 - 4) Blended Hydraulic Cement: ASTM C595/C595M, Type IL, Portland-limestone cement.
- b. Normal-Weight Aggregates: ASTM C33/C33M, Class 4S, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.
- 1) Maximum Coarse-Aggregate Size: 3/4 inch nominal.
 - 2) Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- c. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:
- 1) Aggregate Sizes: 1/2 to 3/4 inch nominal.
 - 2) Aggregate Source, Shape, and Color:
- d. Air-Entraining Admixture: ASTM C260/C260M.
- e. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
- 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.
 - f. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
 - 1) Color: As selected by Architect from manufacturer's full range.
 - g. Water: Potable and complying with ASTM C94/C94M.
5. FIBER REINFORCEMENT
- a. Synthetic Fiber: Monofilament polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C1116/C1116M, Type III, 1/2 to 1-1/2 inches long.
 - b. Synthetic Fiber: Fibrillated polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C1116/C1116M, Type III, 1/2 to 1-1/2 inches long.
6. CURING MATERIALS
- a. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd.dry or cotton mats.
 - b. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.
 - c. Water: Potable.
 - d. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
 - e. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.
 - f. White, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 2, Class B, dissipating.
7. RELATED MATERIALS
- a. Joint Fillers: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D1752, cork or self-expanding cork in preformed strips.
 - b. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, non-glazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

- c. Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- d. Epoxy-Bonding Adhesive: ASTM C881/C881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:
 - 1) Types I and II, non-load bearing or types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- e. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.
- f. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.
 - 1) Color: As selected by Architect from manufacturer's full range.
- g. Rock Salt: Sodium chloride crystals, kiln dried, coarse gradation with 100 percent passing 3/8-inch sieve and 85 percent retained on a No. 8 sieve.

8. CONCRETE MIXTURES

- a. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
 - 1) Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
 - 2) When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.
- b. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent. Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
 - 1) Fly Ash or Pozzolan: 25 percent.
 - 2) Slag Cement: 50 percent.
 - 3) Combined Fly Ash or Pozzolan, and Slag Cement: 50 percent, with fly ash or pozzolan not exceeding 25 percent.
- c. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
 - 1) Air Content: 4-1/2 percent plus or minus 1-1/2 percent for 1-1/2-inch nominal maximum aggregate size.

- 2) Air Content: 4-1/2 percent plus or minus 1-1/2 percent for 1-inch nominal maximum aggregate size.
- 3) Air Content: 5 percent plus or minus 1-1/2 percent for 3/4-inch nominal maximum aggregate size.
- d. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.
- e. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1) Use high-range, water-reducing admixture and plasticizing 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.
- f. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. Yd.
- g. 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.
- h. Concrete Mixtures: Normal-weight concrete.
 - 1) Compressive Strength (28 Days): 3000 psi.
 - 2) Maximum W/C Ratio at Point of Placement: 0.5.
 - 3) Slump Limit: 4 inches, plus or minus 1 inch.

9. CONCRETE MIXING

- a. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M and ASTM C1116/C1116M. Furnish batch certificates for each batch discharged and used in the Work.
 - 1) When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F reduce mixing and delivery time to 60 minutes.
- b. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. 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

1. EXAMINATION

- a. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- b. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
 - 1) Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
 - 2) Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
 - 3) Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 312000 "Earth Moving."
- c. Proceed with installation only after unsatisfactory conditions have been corrected.

2. PREPARATION

- a. Remove loose material from compacted subbase surface immediately before placing concrete.

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.

4. STEEL REINFORCEMENT INSTALLATION

- 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.

- e. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.
- f. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D3963/D3963M.
- g. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

5. JOINTS

- a. General: 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.
 - 1) When joining existing paving, place transverse joints to align with previously placed joints 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) Provide tie bars at sides of paving strips where indicated.
 - 3) Butt Joints: Use bonding agent or epoxy-bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 4) Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
 - 5) Doweled 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, other fixed objects, and where indicated.
 - 1) Locate expansion joints at intervals of 50 feet unless otherwise indicated.
 - 2) Extend joint fillers full width and depth of joint.
 - 3) Terminate joint filler not less than 1/2 inch or more than 1 inch 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.
- 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 existing 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 radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.
 - a) Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.
 - 2) Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
 - a) Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.
 - 3) 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 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

6. CONCRETE PLACEMENT

- a. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
- b. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- c. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- d. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- e. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

- f. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- g. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
 - 1) Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement dowels and joint devices.
- h. Screed paving surface with a straightedge and strike off.
- i. Commence initial floating using bull floats or derbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- j. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.
- k. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
 - 1) Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

7. FLOAT FINISHING

- a. General: Do not add water to concrete surfaces during finishing operations.
- b. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
 - 1) Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
 - 2) Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
 - 3) Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

8. SPECIAL FINISHES

- a. Monolithic Exposed-Aggregate Finish: Expose coarse aggregate in paving surface as follows:

- 1) Immediately after float finishing, spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
 - 2) Cover paving surface with plastic sheeting, sealing laps with tape, and remove when ready to continue finishing operations.
 - 3) Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
 - 4) Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.
- b. Seeded Exposed-Aggregate Finish: Immediately after initial floating, spread a single layer of aggregate uniformly on paving surface. Tamp aggregate into plastic concrete and float finish to entirely embed aggregate with mortar cover of 1/16 inch.
- 1) Spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
 - 2) Cover paving surface with plastic sheeting, sealing laps with tape, and remove sheeting when ready to continue finishing operations.
 - 3) Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
 - 4) Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.
- c. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on paving surface according to manufacturer's written instructions and as follows:
- 1) Uniformly spread 40 lb/100 sq. ft in two applications. Tamp aggregate flush with surface using a steel trowel, but do not force below surface.
 - 2) Uniformly distribute approximately two-thirds of slip-resistive aggregate over paving surface with mechanical spreader, allow to absorb moisture, and embed by power floating. Follow power floating with a second slip-resistive aggregate application, uniformly distributing remainder of material at right angles to first application to ensure uniform coverage, and embed by power floating.
 - 3) Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
 - 4) After curing, lightly work surface with a steel-wire brush or abrasive stone and water to expose nonslip aggregate.
- d. Rock-Salt Finish: After initial floating, troweling, or brooming, uniformly spread rock salt over paving surface at the rate of 5 lb/100 sq. ft.
- 1) Embed rock salt into plastic concrete with roller or magnesium float.
 - 2) Cover paving surface with 1-mil-thick polyethylene sheet and remove sheet when concrete has hardened and seven-day curing period has elapsed.
 - 3) After seven-day curing period, saturate concrete with water and broom-sweep surface to dissolve remaining rock salt, thereby leaving pits and holes.

- e. Pigmented Mineral Dry-Shake Hardener Finish: After initial floating, apply dry-shake materials to paving surface according to manufacturer's written instructions and as follows:
 - 1) Uniformly spread dry-shake hardener at a rate of 100 lb/100 sq. ft. unless greater amount is recommended by manufacturer to match paving color required.
 - 2) Uniformly distribute approximately two-thirds of dry-shake hardener over the concrete surface with mechanical spreader; allow hardener to absorb moisture and embed it by power floating. Follow power floating with a second application of pigmented mineral dry-shake hardener, uniformly distributing remainder of material at right angles to first application to ensure uniform color, and embed hardener by final power floating.
 - 3) After final power floating, apply a hand-troweled finish followed by a broom finish.
 - 4) Cure concrete with curing compound recommended by dry-shake hardener manufacturer. Apply curing compound immediately after final finishing.

9. CONCRETE PROTECTION AND CURING

- a. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- b. Comply with ACI 306.1 for cold-weather protection.
- c. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.
- d. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- e. Curing Methods: Cure concrete by curing compound or a combination of these as follows
 - 1) Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a) Water.
 - b) Continuous water-fog spray.
 - c) Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 - 2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period, using cover material and waterproof tape.
 - 3) Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

10. PAVING TOLERANCES

a. Comply with tolerances in ACI 117 and as follows:

- 1) Elevation: 3/4 inch.
- 2) Thickness: Plus 3/8 inch minus 1/4 inch.
- 3) Surface: Gap below 10-feet-long; unleveled straightedge not to exceed 1/2 inch.
- 4) Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
- 5) Lateral Alignment and Spacing of Dowels: 1 inch.
- 6) Vertical Alignment of Dowels: 1/4 inch.
- 7) Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
- 8) Joint Spacing: 3 inches.
- 9) Contraction Joint Depth: Plus 1/4 inch, no minus.
- 10) Joint Width: Plus 1/8 inch, no minus.

11. FIELD QUALITY CONTROL

a. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

b. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C172/C172M shall be performed according to the following requirements:

- 1) Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
 - a) When frequency of testing will provide 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; 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. Perform additional tests when concrete consistency appears to change.
- 3) Air Content: ASTM C231/C231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
- 4) Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F) and below and when it is 80 deg F and above, and one test for each composite sample.
- 5) Compression Test Specimens: ASTM C31/C31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
- 6) Compressive-Strength Tests: ASTM C39/C39M; test one specimen at seven days and two specimens at 28 days.
 - a) A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

- c. Strength of each concrete mixture will be satisfactory if 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.
- d. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- e. 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.
- f. Additional Tests: 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.
- g. Concrete paving will be considered defective if it does not pass tests and inspections.
- h. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- i. Prepare test and inspection reports.

12. REPAIR AND PROTECTION

- a. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.
- b. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.
- c. Protect 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 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 321313

Section 321723

PAVEMENT MARKINGS

PART 1 GENERAL

1.1 STIPULATIONS

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. Painted pavement markings.

1.3 RELATED REQUIREMENTS

- A. Section 321216 - Asphalt Paving.
- B. Section 321313 - Concrete Paving.

1.4 PRICE AND PAYMENT PROCEDURES

A. Unit Prices:

1. See Section 010250 - Unit Prices in Lump Sum Contracts for additional requirements.
2. Basis of Measurement for Linear Painted or Plastic Pavement Markings: By linear foot (linear meter).
3. Basis of Measurement for Painted or Plastic Pavement Markings Symbols or Text: Per unit.
4. Basis of Measurement for Raised Pavement Markings: Per unit.

1.5 REFERENCE STANDARDS

- A. AASHTO M 237 - Standard Specification for Epoxy Resin Adhesives for Bonding Traffic Markers to Hardened Portland Cement and Asphalt Concrete; 2005 (Reapproved 2019).
- B. AASHTO M 247 - Standard Specification for Glass Beads Used in Pavement Markings; 2013 (Reapproved 2018).
- C. AASHTO M 249 - Standard Specification for White and Yellow Reflective Thermoplastic Striping Material (Solid Form); 2012 (Reapproved 2020).
- D. AASHTO MP 24 - Standard Specification for Waterborne White and Yellow Traffic Paints; 2015 (Reapproved 2020).
- E. ASTM D4505 - Standard Specification for Preformed Retroreflective Pavement Marking Tape for Extended Service Life; 2012 (Reapproved 2017).
- F. ASTM E303 - Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester; 1993 (Reapproved 2018).
- G. FHWA MUTCD - Manual on Uniform Traffic Control Devices; 2023.

1.6 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the work of this section with adjoining work.
- B. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by affected installers.

1.7 SUBMITTALS

- A. See Section 013100 – Sequence of Construction & Milestones for submittal procedures.
- B. Shop Drawings: Indicate survey control points and pavement markings.
- C. Shop Drawings: Indicate traffic management plan with barricades, cones, and temporary markings.
- D. Product Data: Manufacturer's data sheets on each product to be used.
- E. Certificates: Submit for each batch stating compliance with specified requirements.

1. Painted pavement markings.

1.8 Manufacturer's Instructions:

- A. Preparation instructions and recommendations.
- B. Storage and handling requirements and recommendations.
- C. Installation methods.

1.9 Manufacturer's qualification statement.

- A. Installer's qualification statement.

1.10 Maintenance Materials: Furnish the following for Owner's use in maintenance of project

- A. See Section 016000 - Product Requirements for additional provisions.
- B. Extra Paint: 2 containers, 1 gallon (4 liter) size, of each type and color.
- C. Extra Markers: 5 percent, of each type and color.

1.11 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience and approved by manufacturer.

1.12 DELIVERY, STORAGE, AND HANDLING

- A. Deliver paint in containers of at least 5 gallons (18 L) accompanied by batch certificate.
- B. Deliver glass beads in containers suitable for handling and strong enough to prevent loss during shipment, accompanied by batch certificate.
- C. Store products in manufacturer's unopened packaging until ready for installation.
- D. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.13 FIELD CONDITIONS

- A. Do not install products under environmental conditions outside manufacturer's absolute limits.
- B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 degrees F (10 degrees C) or more than 95 degrees F (35 degrees C).

1.14 SEQUENCING

- A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of markings.

PART 2 PRODUCTS

1.15 MANUFACTURERS: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

A. Painted Pavement Markings:

1. Dunn-Edwards Corporation; Vin-L-Stripe Specialty Interior/Exterior Flat Zone Marking Paint.
2. Dunn-Edwards Corporation; Vin-L-Stripe Specialty Interior/Exterior Velvet Zone Marking Paint.
3. PPG Traffic Solutions; Ennis Flint Fast Dry Waterborne Traffic Paint, 9852x Series.
4. Or equal as approved by the design professional.

1.16 Painted Pavement Markings

- A. Comply with Pennsylvania Department of Transportation standards.
B. Comply with FHWA MUTCD.
C. Painted Pavement Markings: As indicated on drawings.

1. Marking Paint: In accordance with AASHTO MP 24.
 - a. Parking Lots: Yellow.
 - b. Symbols and Text: White.
 - c. Wheelchair Symbols: Provide blue and white.
2. Reflective Glass Beads: Type 1, in accordance with AASHTO M 247.
3. Obliterating Paint: Type I, in accordance with AASHTO MP 24.
 - a. Bituminous Pavement: Black.
 - b. Concrete Pavement: Gray.

PART 3 EXECUTION

1.17 EXAMINATION

- A. Identify existing markings for removal.
B. Verification of Conditions: Verify that pavement is dry and ready for installation.
C. Notify Architect of unsatisfactory conditions before proceeding.

1.18 PREPARATION

- A. Establish survey control points for locating and dimensioning of markings.
B. Place barricades, warning signs, and flags as necessary to alert approaching traffic.
C. Clean surfaces prior to installation.
 1. Remove dust, dirt, and other debris.
 2. Remove rubber deposits, existing paint markings, and other coatings.
D. Temporary Markings: Apply as directed by Architect.
E. Apply paint stencils by type and color at necessary intervals.

1.19 INSTALLATION

- A. General:
 1. Position pavement markings as indicated on drawings.
 2. Field location adjustments require approval of Architect.

3. Allow traffic movement without hindrance.

B. Painted Pavement Markings:

1. Apply in accordance with manufacturer's instructions.
2. Apply in accordance with Pennsylvania Department of Transportation (PennDOT) standards.
3. Apply in accordance with FHWA MUTCD standards.
4. Obliterating Paint: Apply as necessary to cover existing markings completely.
5. Marking Paint: Apply uniformly, with sharp edges.
 - a. Applications: One coat.
6. Wet Film Thickness: 0.015 inch (0.4 mm), minimum.
7. Stencils: Lay flat against pavement, align with striping, remove after application.
8. Glass Beads: Apply directly to paint, 10 second lag time, 6 lbs/gal (720 g/L) of paint, uniform thickness and coverage.
9. Length Tolerance: Plus or minus 3 inches (75 mm).
10. Width Tolerance: Plus or minus 1/8 inch (3 mm).

1.20 TOLERANCES

- A. Maximum Variation From True Position: 3 inches (76 mm).
- B. Maximum Offset From True Alignment: 3 inches (76 mm).

1.21 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Control Testing Services and Section 014010 – Quality Assurance Testing and Inspection Services for requirements and additional requirements.
- B. Perform field inspection for deviations from true alignment or material irregularities.
- C. If inspections indicate work does not meet specified requirements, rework and reinspect at no cost to Owner.
- D. Allow the pavement marking to set at least the minimum time recommended by manufacturer.

1.22 CLOSEOUT ACTIVITIES

- A. Temporary Markings: Remove without damaging surfaces.

1.23 PROTECTION

- A. Prevent approaching traffic from crossing newly applied pavement markings.
- B. Replace damaged or removed markings at no additional cost to Owner.
- C. Preserve survey control points until pavement marking acceptance.

END OF SECTION 321723

Section 323300

SITE FURNISHINGS

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. Bollard
 - 2. Bollard HDPE Sleeve

1.3 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 Initial Selection: For units with factory-applied finishes.
- D. Product Schedule: For site furnishings. Use same designations indicated on Drawings.
- E. Shop Drawings:
 - 1. Provide for Bollard and Bollard layout.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For site furnishings to include in maintenance manuals.

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. Maintenance Data: For site furnishings to include in maintenance manuals.
- B. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:
 - 1. Bollard
 - 2. Bollard HDPE sleeve
- C. BOLLARD: Subject to compliance with requirements, provide the following:
 - 1. 6" round domed Concrete Bollard
 - 2. Basis of Design: ULINE
 - a. 12575 Uline Drive, Pleasant Prairie, WI 53158
 - b. Ph: 1(800) 295-5510

- c. www.uline.com/BL_1534/Safety-Bollards
 - 3. Traffic Safety Store – Additional Manufacturer 1
 - a. 1247 Wright's Lane, Unit E, West Chester, PA 19380
 - b. PH: 1(800) 429-9030
 - c. www.trafficsafetystore.com
 - 4. Wausau Tile – Additional Manufacturer 2
 - a. 9001 Bus. Hwy 51, Rothschild, WI 54474
 - b. PH: (715) 359-3121
 - c. <https://wausautile.com>
 - 5. Or equal as approved by design professional.
- D. BOLLARD HDPE SLEEVE: Subject to compliance with requirements, provide the following:
- 1. 6" round Concrete Bollard HDPE sleeve
 - 2. Basis of Design: ULINE P
 - a. 12575 Uline Drive, Pleasant Prairie, WI 53158
 - b. Ph: 1(800) 295-5510
 - c. www.uline.com/BL_1534/Safety-Bollards
 - 3. Traffic Safety Store – Additional Manufacturer 1
 - a. 1247 Wright's Lane, Unit E, West Chester, PA 19380
 - b. PH: 1(800) 429-9030
 - c. www.trafficsafetystore.com
 - 4. Post Guard – Additional Manufacturer 2
 - a. 37525 Interchange Dr. Farmington Hills, MI 48335
 - b. PH: 1(866) 737-8900
<https://www.postguard.com/>
 - 5. Or equal as approved by design professional.

1.6 MATERIALS

- A. Stainless Steel: Free of surface blemishes and complying with the following:
 - 1. Pipe: Schedule 40 steel pipe complying with ASTM A 312/A 312M.
 - 2. Tubing: ASTM A 554.
- B. Anchors, Fasteners, Fittings, and Hardware: Stainless steel or Manufacturer's standard, corrosion-resistant-coated or noncorrodible materials; commercial quality, tamperproof, vandal and theft resistant, concealed, recessed, and capped or plugged.
- C. Non-shrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M; recommended in writing by manufacturer, for exterior applications.
- D. Erosion-Resistant Anchoring Cement: Factory-packaged, non-shrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound; resistant to erosion from water exposure without needing protection by a sealer or waterproof coating; recommended in writing by manufacturer, for exterior applications.

1.7 FABRICATION

- A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.
- B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.
- C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.
- D. Preservative-Treated Wood Components: Complete fabrication of treated items before treatment if possible. If cut after treatment, apply field treatment complying with AWWA M4 to cut surfaces.
- E. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.
- F. Factory Assembly: Assemble components in the factory to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

1.8 GENERAL FINISH REQUIREMENTS

- 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.

1.9 STEEL AND GALVANIZED-STEEL FINISHES

- A. A. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

1.10 STAINLESS-STEEL FINISHES

- A. A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and brush surfaces to produce uniform finish, free of cross scratches.
 - 1. Run directional finishes with long dimension of each piece.
 - 2. Directional Satin Finish: No 4.
 - 3. Dull Satin Finish: No. 6.

PART 2 - EXECUTION

2.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

2.2 INSTALLATION, GENERAL

- A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.
- B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.
- C. Install site furnishings level, plumb, true, and securely anchored at locations indicated on Drawings.
- D. Post Setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.
- E. Posts Set into Voids in Concrete: Form or core-drill holes for installing posts in concrete to depth recommended in writing by manufacturer of site furnishings and ½ inch (19 mm) larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with non-shrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.
- F. Pipe Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with non-shrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

END OF SECTION 334211

SECTION 329113

SOIL 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 SUMMARY

- A. Section Includes:
 - 1. Components of planting mediums.
 - 2. Testing and certification of components.
 - 3. Mixing of planting mediums.
 - 4. Transporting of mediums.
 - 5. Soil and soil amendments products including all imported landscape soil as required to make-up deficiencies in quantity of stockpiled native topsoil available on site.

1.3 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Finish Grade: Elevation of finished surface of planting soil.
- C. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.
- D. Topsoil: Soil with organic content suitable for sustaining the growth of a soil stabilizing groundcover such as turf. Topsoil is spread over prepared subgrade.
 - 1. Stockpiled Native Topsoil: Topsoil stripped from the site prior to rough grading work to be spread and amended as specified (When available). No onsite soil may be used as topsoil unless approved by Landscape Architect. Soil cut from non-organic layers will not be considered for use as topsoil.
 - 2. Imported Landscape Topsoil: Off-site topsoil imported and stockpiled to be spread and amended as specified.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated, furnish manufacturer's literature, certifications, sources, samples, and laboratory analytical data.
1. Organic amendments.
 2. Topsoil.
 3. Sand.
 4. Mulch.
 5. Plant bed mix.
 6. Fertilizer.
 7. Soil amendments.
 8. Pre-emergent herbicide.

1.5 QUALITY ASSURANCE

- A. Testing: refer to Section 014000 – Quality Control Testing Services for additional information.
- B. Soil testing laboratory shall be approved by Owner. Soil laboratory shall be capable of providing all tests outlined in this section and shall provide recommendations and rates of applications per 1000 sq. ft. for soil amendments, soil chemistry, and soil placement.
1. All costs for testing shall be paid for by Contractor.
 2. Materials to be Tested:
 - a. Stockpiled Native topsoil - 3 samples minimum from at least 3 different locations within the stockpile.
 - b. Imported Landscape soils - 3 samples minimum from at least 3 different locations within the stockpile.
 3. Agricultural Test Reports: Stockpiled Native Topsoil, Imported Landscape Soils, and Subgrade Soil shall be tested as follows:
 - a. Fertility (as expressed in measures of pH, salinity, nitrates, ammonium, phosphate, potassium, calcium, and magnesium).
 - b. Agricultural Suitability (sodium absorption ratio, sodium acetate and extractable calcium).
 - c. Particle Size: Classify the soil by USDA standards including particle size and organic content notations. Lab reports to conform to material specification description for sieve sizes.
 - d. Heavy metals (cadmium, lead, arsenic, aluminum).
 - e. Soils lab may require additional tests due to field conditions.
 4. Fertility Considerations: In the event of nutrient inadequacies, provisions shall be made to add required materials in soils to overcome inadequacies prior to planting.
 5. Imported Landscape Topsoil: Test for herbicide contamination.
 6. Certificates: Certify strict compliance with accepted soil mixes and amendments, including rate of application.

PART 2 - PRODUCTS

2.1 NATIVE LANDSCAPE TOPSOIL

A. Stockpiled Native Topsoil

1. Quantity: Approximate quantity of stockpiled native topsoil will not be known until demolition and rough grading have been completed under Civil Work.
2. Stockpiling: Stockpile stripped topsoil onsite.
3. Composition: Fertile, friable, well-drained soil, of uniform quality, free of stones over 1-inch diameter, sticks, oils, chemicals, plaster, concrete and other deleterious materials.
4. Analysis: Obtain an agricultural suitability analysis of the proposed topsoil from an accepted, accredited Testing Agency at Contractor's cost.
5. Test Results: Request Testing Agency to send one (1) copy of test results directly to Landscape Architect and one (1) copy to the Owner. Imported topsoil shall be amended per soils analysis report.

2.2 IMPORTED TOPSOIL

A. Grading:

Sieve Size	Percent Passing Sieve
25.4 mm (1")	95-100
9.5 mm (3/8")	85-100
53 Micron (270 mesh)	10-30

B. Chemistry - Suitability Considerations:

1. Salinity: Saturation Extract Conductivity (ECe x 103 @ 25 degrees C.) less than 4.0.
2. Sodium: Sodium Absorption Ratio (SAR) less than 9.0.
3. Boron: Saturation Extract Concentration less than 1.0 PPM.
4. Reaction: pH of Saturated Paste: 6.0- 7.5.

C. Pests: The population of any single species of plant pathogenic nematode shall be fewer than 500 per pint of soil.

D. Fertility Considerations: Soil to contain sufficient quantities of available nitrogen, phosphorus, potassium, calcium, and magnesium to support normal plant growth. In the event of nutrient inadequacies, provisions shall be made to add required materials to overcome inadequacies prior to planting.

E. Source of above shall be approved and conformity of material shall be laboratory verified for each 100 cubic yards of material delivered to the site.

F. Composition: Fertile, friable, well drained soil, of uniform quality, free of stones over 1 in. diameter, sticks, oils, chemicals, plaster, concrete and other deleterious materials.

2.3 PINE BARK MULCH

- A. Finely ground decomposed pine bark.
- B. White wood or filler material is not allowed.
- C. Submit sample for approval.

2.4 SAND

- A. Grading: Clean bank sand free of deleterious materials and clumps larger than 1 inch in diameter.
- B. Planting Bed Mix/Tree Backfill: Sharp sand.

2.5 CHEMICAL ADDITIVES

- A. The following soil components listed shall be applied at rates shown as determined by soil tests. Till additives into existing soil for all grassed areas.
 - 1. Gypsum: Agricultural grade product containing 80 percent minimum calcium sulphate. Apply at a rate of 6lbs./1000 sq. ft.
 - 2. Boil Sulphur: Agricultural grade sulphur containing a minimum of 96 percent sulphur. Apply at a rate of .2 lbs./1000 sq. ft.
 - 3. Apply the following micronutrients at the rates shown:
 - a. Zinc: .05 ounces/1000 sq. ft.
 - b. Manganese: .05 ounces/1000 sq. ft.
 - c. Copper: .05 ounces/1000 sq. ft.

2.6 PLANTING MEDIA

- A. Thoroughly mix planting media in the following proportions:
 - 1 part sharp sand
 - 1 part topsoil
 - 1 part pine bark mulch
- B. The ratio of mix components may be altered during Contract period to meet site conditions found different in various Project areas.
 - 1. Chemical additives – determined by soil tests.
 - 2. Maintain pH at 6.5 to 7.5.

PART 3 - EXECUTION

3.1 SOIL MOISTURE CONTENT

- A. Do not work soil when the following conditions occur:
 - 1. Moisture content is so great that excessive compaction will occur.
 - 2. When it is so dry that dust will form in air or where clods will not break readily.
 - 3. When it is frozen.
- B. Apply water if necessary to bring soil to optimum moisture content for tilling and planting.

3.2 CLEARING AND CULTIVATION

- A. Clearing: Clear all planting areas of stones 1-1/2 in. diameter and larger, weeds, debris and other extraneous materials prior to soil preparation work.
- B. Cultivation of Subgrade:
 - 1. Verification:
 - a. Verify that subgrades for installation of stockpiled native topsoil and imported landscape soil have been established under rough grading and have been approved by the landscape architect. Do not spread landscape soil prior to acceptance of subgrade work.
 - b. Depth: Verify that subgrades are 4-inch minimum below finished grades, + 1 inch. Report all variations.
 - 2. Cultivation: Rip or cultivate rough grade in all lawn and planting areas to a depth of 4 inches immediately prior to spreading stockpiled native topsoil or imported landscape soil.

3.3 SPREADING, DEPTH, AND AMENDING OF IMPORTED LANDSCAPE SOIL

- A. Sequence: Existing soil subgrade cultivation and amending to be approved prior to spreading stockpiled native topsoil or imported landscape soils.
- B. Install stockpiled topsoil in low areas to bring the rough grade to within plus or minus 1 foot.
- C. Place in lifts of 3 inches maximum where necessary.

3.4 MIXING

- A. Till soil amendments into existing soil for grassed areas with the use of mechanical tiller to a depth of 4 inches.

- B. Mix soil base, amendments, and chemical additives by mechanical means. Do not mix additives with excavated material at the plant pit site.
- C. Mechanical means should thoroughly mix all amendments with soil or soil-less base.
- D. Soil and sand bases shall be completely pulverized and free of lumps or aggregated material. The moisture content of base materials shall not be such that chemical granular or pelletized additives become dissolved before thorough mixing.
- E. Mix media in quantities of not less than 50 cubic yards or mix total quantity required if less than 100 cubic yards. The contractor shall be responsible for continuity between batches.
- F. The Contractor shall keep in storage, at his own expense, sufficient quantities of mix to repair any settling or to adjust grades throughout the warranty period.

3.5 FIELD QUALITY CONTROL

- A. Landscape Architect reserves the right to take and have a Soils Testing Laboratory analyze soil samples at the site.
- B. Immediately remove rejected materials from site. Replacements are subject to all specified requirements.
- C. Contractor shall bear final responsibility for proper surface drainage of planted areas. Any discrepancy in the Drawings or Specifications, obstructions on the site, or prior work done by another party, which Contractor feels precludes establishing proper drainage shall be brought to the attention of Landscape Architect in writing for correction or relief of said responsibility.

END OF SECTION 329113

SECTION 329200
TURF AND GRASSES

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.

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Sodding.
 - 2. Lawn renovation.
- B. Related Sections:

- 1. Section 311000 - "Site Clearing" for topsoil stripping and stockpiling.
- 2. Section 312000 - "Earth Moving" for excavation, filling and backfilling, and rough grading.
- 3. Section 329113 - "Soil Preparation" for site soil details.

1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Planting Soil: Native or imported topsoil mixed with soil amendments.
- C. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.
- D. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For qualified landscape Installer.
- C. Product Certificates: For soil amendments and fertilizers, from manufacturer.
- D. Material Test Reports: For existing and imported topsoil.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful lawn and meadow establishment.
 - 1. Installer's Field Supervision: Require Installer to maintain an experienced fulltime supervisor on Project site when planting is in progress.
 - 2. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- C. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; deleterious material; pH; and mineral and plant-nutrient content of topsoil.
 - 1. Report suitability of topsoil for lawn growth. State-recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory topsoil.
- D. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Sod: Harvest, deliver, store, and handle sod according to requirements in TPI's "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in its "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.

1.7 PROJECT CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.
 - 1. Spring Planting: March 1st – May 15th.
 - 2. Fall Planting: September 1st – November 30th.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

1.8 MAINTENANCE SERVICE

- A. Initial Lawn 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 acceptable lawn is established, but for not less than the following periods:

1. Sodded Lawns: 60 days from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TURFGRASS SOD

- A. Turfgrass Sod: Certified, complying with TPI's "Specifications for Turfgrass Sod Materials" in its "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.
- B. Turfgrass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
 1. Full Sun: Kentucky bluegrass (*Poa pratensis*), a minimum of three cultivars.

2.2 TOPSOIL

- A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.
 1. Topsoil Source: Import topsoil or topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.
 2. Stones may comprise no more than 10% of the total topsoil volume

2.3 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural limestone containing a minimum of 80 percent calcium carbonate equivalent and as follows:
 1. Class: T, with a minimum of 99 percent passing through No. 8 sieve and a minimum of 75 percent passing through No. 60 sieve.

2.4 PLANTING ACCESSORIES

- A. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.

2.5 FERTILIZER

- A. 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: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.6 PLANTING SOIL MIX

A. Planting Soil Mix: Topsoil mixed with the following soil amendments and fertilizers in the following quantities:

1. Weight of Lime per 1000 Sq. Ft.: As determined by Soil Test.
2. Weight of Sulfur per 1000 Sq. Ft.: As determined by Soil Test.
3. Weight of Commercial Fertilizer per 1000 Sq. Ft.: As determined by Soil Test.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect grade stakes set by others until directed to remove them.

3.3 LAWN PREPARATION

A. Limit lawn subgrade preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.

- a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
- b. Mix lime with dry soil before mixing fertilizer.

2. Spread planting soil mix to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

- a. Spread approximately 1/2 the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil mix.
- b. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Unchanged Subgrades: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
 2. Loosen surface soil to a depth of at least 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.
 - a. Apply fertilizer directly to surface soil before loosening.
 3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
 4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.
- D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.
- E. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- F. Before planting, restore areas if eroded or otherwise disturbed after finish grading.

3.4 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 subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, 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 across angle of slopes exceeding 1:3.
 2. Anchor sod on slopes exceeding 1:6 with wood pegs spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.
- 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.

3.5 LAWN RENOVATION

- A. Renovate existing lawn.
- B. Renovate existing lawn damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
1. Reestablish lawn where settlement or washouts occur or where minor regrading is required.
 2. Provide new topsoil as required.

- C. Remove sod and vegetation from diseased or unsatisfactory lawn areas; do not bury in soil.
- D. Remove topsoil containing foreign materials resulting from Contractor's operations, including oil drippings, fuel spills, stone, gravel, and other construction materials, and replace with new topsoil.
- E. Mow, dethatch, core aerate, and rake existing lawn.
- F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
- G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.
- H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.
- I. Apply soil amendments and initial fertilizers required for establishing new lawns and mix thoroughly into top 4 inches of existing soil. Provide new planting soil to fill low spots and meet finish grades.
- J. Apply sod and protect as required for new lawns.
- K. Water newly planted areas and keep moist until new lawn is established.

3.6 LAWN MAINTENANCE

- A. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn. Provide materials and installation the same as those used in the original installation.
- B. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn 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 lawn with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.
- C. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet.
Schedule initial and subsequent mowings to maintain the following grass height:
 - 1. Mow grass to a height of 2 to 3 inches.
- D. Lawn Postfertilization: Apply fertilizer after initial mowing and when grass is dry.
 - 1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to lawn area.

3.7 SATISFACTORY LAWNS

- A. Lawn installations shall meet the following criteria as determined by Architect:
 - 1. Satisfactory Sodded Lawn: At end of maintenance period, a healthy, well-rooted, even-colored, viable lawn has been established, free of weeds, open joints, bare areas, and surface irregularities.
- B. Use specified materials to reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

3.8 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris, created by lawn work, from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. 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 lawn is established.

END OF SECTION 329200

Section 334211

STORMWATER GRAVITY PIPE

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. Stormwater drainage piping.
 - 2. Stormwater pipe accessories.
 - 3. Stormwater manholes
 - 4. Trenching

1.3 RELATED REQUIREMENTS

- A. Sections:
 - 1. Section 312000 – Earth Moving

1.4 PRICE AND PAYMENT PROCEDURES

- A. Pipe and Fittings:
 - 1. Basis of Measurement: By the linear feet.
 - 2. Basis of Payment: Includes hand trimming excavation, bedding and backfilling, pipe and fittings, connection to building service piping and to municipal system.

1.5 REFERENCE STANDARDS

- A. ASTM Specifications:
 - 1. ASTM C14 - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe; 2020.
 - 2. ASTM C14M - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe (Metric); 2020.
 - 3. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe; 2022a.
 - 4. ASTM C76M - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric); 2022a.
 - 5. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets; 2021.

6. ASTM C443M - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric); 2021.ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2020a.

1.6 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the installation of stormwater gravity piping with size, location and installation of stormwater drains.
- B. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
- C. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.7 SUBMITTALS

- A. See Section 013100 – Sequence of Construction & Milestones, for submittal procedures.
- B. Product Data: Provide data indicating pipe, pipe accessories,
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
- E. Field Quality Control Submittals: Document results of field quality control testing.
- F. Project Record Documents
- G. Record location of pipe runs, connections, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 PRODUCTS

2.1 STORMWATER PIPE MATERIAL

- A. Provide products that comply with applicable code(s).
- B. Corrugated Steel Pipe: AASHTO M 36 Type I; nominal diameter of 24 inches, 24 in end joints; helical lock seam; coated inside and out with 0.050 inch (1.3 mm) thick bituminous coating.
- C. Coupling Bands: Galvanized steel, 0.052 inches (1.3 mm) thick x 10 inches (250 mm) wide; connected with two neoprene "O" ring gaskets and two galvanized steel bolts.

2.2 PIPE ACCESSORIES

- A. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.
- B. Finish: Manufacturer's standard factory applied powder coat finish.
- C. Color: To be selected by Architect from manufacturer's standard range.
- D. Accessories: Manufacturer's standard stainless-steel fasteners, stainless steel building wall anchors, and rubber coupling.

2.2 STORMWATER MANHOLES

- A. Manholes shall be brick, cast-in-place concrete, or precast reinforced concrete manhole sections. Manholes built into sanitary sewers with inverts below elevation 0.00 City datum or into any
- B. intercepting sewers shall be restricted to cast-in-place concrete or precast reinforced concrete sections.

- D. Manholes shall be constructed with steps and/or ladder bars from the inverts of the sewer or stormwater conduit to the top of the manhole.
- E. Manholes built into sanitary sewers or combined sewers shall be fitted with cast iron frames and solid covers. Manhole built into stormwater conduits shall be fitted with cast iron frames and solid or vented covers.

PART 3 - EXECUTION

3.1 TRENCHING

- A. See Section 311000 – Site Clearing and Section 312000 - Earth Moving for additional requirements.
- B. Hand trim excavation for accurate placement of pipe to elevations indicated.
- C. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.2 INSTALLATION

- A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.
- B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal
- C. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).
- D. Connect to building storm drainage system, foundation drainage system, and utility/municipal system.
- E. Make connections through walls through sleeved openings, where provided.
- F. Install continuous trace wire 6 inches (150 mm) above top of pipe; coordinate with Section 312316.13.

3.3 FIELD QUALITY CONTROL

- A. Perform field inspection in accordance with Section 014000 - Quality Control Testing Services requirements.
- B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

3.4 PROTECTION

- A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION 334211