

SPECIFICATIONS

PROJECT NO. DGS C-114-06 PHASE 1

Volume 1

**Contract No. DGS C-114-06 Phase 1.1 – General Construction
Contract No. DGS C-114-06 Phase 1.2 – HVAC Construction
Contract No. DGS C-114-06 Phase 1.3 – Plumbing Construction
Contract No. DGS C-114-06 Phase 1.4 – Electrical Construction**

For

**Hickory Run State Park Latrine Improvements
Hickory Run State Park
White Haven, Carbon County, PA**

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

**Thomas W. Wolf, Governor
Joseph H. Lee, Acting Secretary
Department of General Services**



Construction Documents

Date: June 17, 2022

**SMP Architects
1600 Walnut Street, Philadelphia PA 19103
Phone: 215-985-4410**

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Volume 2

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Approvals

Kidder Township Land Development – 10/17/2022
 NPDES – Stormwater Management – 8/16/2022
 Carbon County Soil Erosion and Sedimentation Control – 8/16/2022
 Carbon County Post-Construction Stormwater Management – 8/16/2022
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 DEP – Kidder Township Sanitary Sewer Planning Module – 5/24/2022
 PHMC- Pennsylvania Historical & Museum Commission- Archeological Approval – 7/6/2020
 PHMC – Historical Building Approval – 7/6/2020

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. Hickory Run State Park, 3 Family Camp Road, White Haven, PA 18661

1.3 PROJECT DESCRIPTION

- A. The project consists of replacing three pit toilets in the Loop C Family Campground with one shower house, replacing one existing washhouse in both Organized Group Camps (OGC) with a shower house, and constructing one flush comfort station in the Organized Group Tent (OGTC) Camping area and other Work indicated in the Contract Documents.

1.4 CONTRACT DURATION

- A. The Construction Contract duration shall be 241 calendar days commencing on the date of the Initial Job Conference.

1.5 WORK INCLUDED

- A. The Work of this Project consists of, but is not necessarily limited to, the following. Detailed requirements of the Work are described in the pertinent specification Sections and/or shown on the Drawings.
- B. General Construction (.1) Contract:
 - 1. Concrete
 - 2. Anchored Stone Veneer Masonry
 - 3. Structural Steel
 - 4. Shop Fabricated Wood Trusses
 - 5. Fiber Cement Siding
 - 6. Selective Demolition
 - 7. Sitework
 - 8. Concrete Masonry Units
 - 9. Interior Finish Materials
- C. HVAC Construction (.2) Contract:
 - 1. Radiant floors
 - 2. Energy recovery ventilation
 - 3. Boilers
 - 4. Electric wall heaters and Horizontal unit heaters
 - 5. Ductwork and diffusers
 - 6. Air intake and exhaust louvers

- D. Plumbing Construction (.3) Contract:
 - 1. Commercial water closets, urinals, lavatories, sinks, and showers
 - 2. Domestic water piping
 - 3. Sanitary waste, vent piping, and drains

- E. Electrical Construction (.4) Contract:
 - 1. LED light fixtures
 - 2. Digital lighting control devices
 - 3. Low voltage transformers, switchboards, panelboards
 - 4. Conduit, wiring, and devices

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. Throughout the Specifications and Drawings wherever the terms 'A/E', 'Architect' or 'Engineer' are used it shall mean Professional.

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 010250

UNIT PRICES IN LUMP SUM CONTRACTS

PART 1 – GENERAL

1.1 STIPULATIONS

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

1.2 DEFINITIONS

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

1.3 PROCEDURES

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

1.4 SCHEDULE OF UNIT PRICES

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

GENERAL CONSTRUCTION (.1) CONTRACT – SCHEDULE OF UNIT PRICES			
ITEM NO.	DESCRIPTION	UNIT OF MEASUREMENT	QUANTITY IN LUMP SUM BID
1	Removal and replacement of water line	Linear Feet	50 LF
2			
3			

HVAC CONSTRUCTION (.2) CONTRACT – SCHEDULE OF UNIT PRICES			
ITEM NO.	DESCRIPTION	UNIT OF MEASUREMENT	QUANTITY IN LUMP SUM BID
1			
2			
3			

PLUMBING (.3) CONTRACT – SCHEDULE OF UNIT PRICES			
ITEM NO.	DESCRIPTION	UNIT OF MEASUREMENT	QUANTITY IN LUMP SUM BID
1			
2			
3			

ELECTRICAL (.4) CONTRACT – SCHEDULE OF UNIT PRICES			
ITEM NO.	DESCRIPTION	UNIT OF MEASUREMENT	QUANTITY IN LUMP SUM BID
1			
2			
3			

1.5 CHANGES

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

1.6 MEASUREMENT

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

1.7 DESCRIPTIONS OF UNIT PRICES

A. General Construction (.1) Contract:

1. Unit Price 1: Provide a unit cost for removal of existing damaged underground water line and replacement with new water line.

B. HVAC Construction (.2) Contract:

1. Unit Price 1: n/a

C. Plumbing Construction (.3) Contract:

1. Unit Price 1: n/a

D. Electrical Construction (.4) Contract

1. Unit Price 1: n/a

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-114-06 PHASE 1.1)

- 1. Base Bid No. 1:
 - a. Shall include all the work indicated on the Contract Drawings and described in the Contract Specifications required to construct the buildings at Loop C and Organized Group Tent Camp.
- 2. Base Bid No. 2:
 - a. Same as Base Bid No. 1, except add the construction of the building at Camp Shehaqua.
- 3. Base Bid No. 3:
 - a. Same as Base Bid No. 2, except add the construction of the building at Camp Daddy Allen.

B. HVAC CONSTRUCTION CONTRACT (DGS C-114-06 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 required to construct the buildings at Loop C and Organized Group Tent Camp.
- 2. Base Bid No. 2:
 - a. Same as Base Bid No. 1, except add the construction of the building at Camp Shehaqua.
- 3. Base Bid No. 3:

- a. Same as Base Bid No. 2, except add the construction of the building at Camp Daddy Allen.

C. PLUMBING CONSTRUCTION CONTRACT (DGS C-114-06 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 required to construct the buildings at Loop C and Organized Group Tent Camp.

2. Base Bid No. 2:

- a. Same as Base Bid No. 1, except add the construction of the building at Camp Shehaqua.

3. Base Bid No. 3:

- a. Same as Base Bid No. 2, except add the construction of the building at Camp Daddy Allen.

D. ELECTRICAL CONSTRUCTION CONTRACT (DGS C-114-06 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 required to construct the buildings at Loop C and Organized Group Tent Camp.

2. Base Bid No. 2:

- a. Same as Base Bid No. 1, except add the construction of the building at Camp Shehaqua.

3. Base Bid No. 3:

- a. Same as Base Bid No. 2, except add the construction of the building at Camp Daddy Allen.

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-114-06 PHASE 1.1 General Construction (Lead Contractor)
- B. DGS C-114-06 PHASE 1.2 HVAC Construction
- C. DGS C-114-06 PHASE 1.3 Plumbing Construction
- D. DGS C-114-06 PHASE 1.4 Electrical Construction

1.4 VISIT TO SITE

- A. For access to the site during the bidding period contact the Client Agency site personnel with phone number listed below:
 - 1. Client Agency Site Representative: Rex Bradish
 - 2. Telephone Number: (272) 808-6189

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

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

of Federal Regulations, Title 40, Part 61, Section 112 of Clean Air Act and PA Department of Labor and Industry, Act 194 for asbestos.

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

1.6 LEAD PAINT

- 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.

- A. Provide digital photographs of specific project conditions as required at the request of the Department or the Professional.

1.10 INSTRUCTIONS AND TRAINING

- A. Refer to the General Conditions of the Construction Contract, as specified in the applicable technical portion of each specification for "Operations and Maintenance Instruction Manuals" and "Record Drawings" requirements.
- B. Unless approved by the Department, training shall not be scheduled/conducted until Record Drawings, Operation and Maintenance Instruction Manuals, valve tag lists, equipment and piping system identification, and all software programming is complete.
- C. Provide full on-site training and instruction to designated Commonwealth personnel given by competent manufacturer's authorized personnel thoroughly familiar with all technical and operational aspects of the installed items. Instructions are to cover operation and maintenance of all systems, equipment components and other items as specified and furnished under this contract. Instructional digital video recordings may be used to augment required instructions and training but may not be substituted for the in person on-site training. All on-site training shall be digitally recorded by the Contractor. The digital video files are to be turned over to the Client Agency.
- D. Contractor shall provide an outline of the training and course content, which shall be submitted and accepted by the Professional and the Department prior to conducting training.
- E. Conduct instruction and training during regular working hours. For training on complicated systems, allow at least one-half of the training time to be at and/or with the system equipment.
- F. Provide additional training and instructions for all significant modifications and/or changes made under the terms and/or conditions of the manufacturer's and/or Contractor's warranty.
- G. The Contractor shall maintain and submit a sign-in list that clearly documents all personnel attending the training.

1.11 PROJECT SIGN

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

1.12 REUSE OF MATERIALS

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

1.13 GENERAL

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

1.14 WORKING HOURS

- A. The Contractor's available working hours shall be from 8 A.M. to 6 P.M., Monday through Thursday and 8 A.M. to 3 P.M., Friday unless approved otherwise.
- 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 interruptions to occupied and available camping areas are only to occur outside of camping season and requires approval in advance. 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 for construction vehicles and trailers shall be limited to designated areas within the limit of construction at each of the four project sites. Additional parking will be available near the well house to the west of the OGTC site as indicated on the drawings. All parking is subject to prior approval of the Department and Client Agency.

1.17 TRAFFIC

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

1.18 SUBSURFACE INFORMATION

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

1.19 SITE FENCE

- A. See Drawings for site fencing extent and requirements.

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.

Northeast Regional Office
 2 Public Square
 Wilkes-Barre, Pa 18701-1915
 (570) 826-2511

Counties: Carbon, Lackawanna, Lehigh,
 Luzerne, Monroe, Northampton,
 Pike, Schuylkill, Susquehanna,
 Wayne, and Wyoming

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 COORDINATOR OFFICE

- A. The Lead Contractor shall prepare a drawing of the DGS Construction Coordinator Office along with proposed arrangement of the Contractor's Office and construction staging area for the Department's approval. An electronic copy in .pdf format of the sketch plan is to be submitted through e-Builder to the Department within 7 calendar days of Effective Date of Contract or issuance of Letter of Intent whichever occurs first.

- B. The Lead Contractor shall furnish, within five (5) days of the Department's approval of the Lead Contractor's drawing, a suitably finished mobile office of at least 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. Standard flushing toilet required. RV/Camper type toilet not acceptable.
 6. A first quality mercury thermometer on outside of the DGS Construction Manager Office which records the high and low temperature for the day
 7. The Lead contractor shall arrange for all electrical power hook-up/service (as well as water and sanitary, if required), and shall be responsible for all cost necessary to provide these services to the DGS Construction Manager Office (including monthly utility costs). A temporary electric service shall be ordered from the utility provider. If the temporary electrical service is not readily available from the utility provider, a temporary generator shall be provided and maintained (including fuel) until such time power can be established.)
 8. The Lead Contractor to install (4) 9'x20' parking spaces directly adjacent to the DGS Construction Manager Office location. Specific location of parking spaces to be coordinated with Constuction Project Manager.
 9. Sanitary holding tank (to accommodate item 5 above) with capacity for three persons for a week, plus one weekly meeting with 12 persons. Tank shall be protected from freezing. Tank shall be emptied on weekly basis, more often if needed. Contractor shall arrange and be responsible for all cost necessary to provide this service to the field office (including all pickup and dump charges).
 10. Domestic water holding tank with the same capacity as item 9 above (sized accordingly), to accommodate item 5 above.
- C. Equipment: The Lead Contractor shall furnish, with the DGS Construction 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) for the duration of the Contract. If any equipment fails, it shall be repaired or replaced by the Lead Contractor within twenty-four (24) hours of being notified by the Department.

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

1. 2 Desk(s) with swivel chair(s)
2. 2 Electronic calculator
3. 1 Plans table(s) with stools
4. 1 12" deep shelving units of thirty (30) lineal feet

5. 3 Six (6) foot table(s)
6. 12 Chair(s)
7. 1 Clothes tree or closet with rod

8. 1 Provide an all in one print/copy/scan/fax machine capable of producing 35 pages per minute double sided on 8-1/2"x11" and 11"x17". Machine shall be wireless capable and network capable.
9. 2 Safety glasses
10. 1 Fire Extinguisher
11. 1 First-Aid Kit
12. 1 Water cooler, with hot and cold taps
13. 1 Telephones (cordless, with speaker phone capabilities), and answering machine.
14. 2 Trash cans
15. 2 Plain white ANSI approved hardhats

IT Hardware/Peripherals:

16. 2 Computer monitor(s) - basis of design - Hewlett Packard ProDisplay P232 - 23"
17. 2 Keyboard - basis of design - Hewlett Packard KU-1156
18. 2 Docking station with all associated cables for connection of all peripheral devices to support the Hewlett Packard Revolve 810 - Basis of design - HP 2013 UltraSlim Docking Station.
19. 2 Mouse - optical mouse with USB cord, dual button and scroll wheel
Basis of design - Hewlett Packard
20. 1 55" High Definition LED flat panel monitor with wall mount bracket and remote. Monitor shall be network/wireless capable, 120Hz, 1080P.
21. 1 Wireless connectivity to the 55" High Definition LED flat panel monitor shall be accomplished with a wireless receiver and transmitter – Basis of design - ScreenBeam Mini2 wireless receiver (Catalog # SBWD60A01) and a ScreenBeam USB Transmitter 2 (Catalog # SBWD200TX02).
22. 1 12 Month Wall Calendar - 20"x30" - Basis of design AT-A-GLANCE, Model #PM4-28-17

D. The DGS Construction Coordinator Office shall be equipped by the Lead Contractor with telephone cabling and jacks to connect one (1) telephone voice line for use by DGS Personnel. The Lead Contractor shall provide up to four (4) modular telephone jacks (RJ-11 connectors) in the main office area in locations indicated on the approved office plan accepted by the Department for use with the Contractor provided phones. The Lead Contractor will install telephone cable to connect each jack to the demarcation point where the local telephone company provides service (utility pole, telephone room or other access point). The Lead Contractor shall place orders to the local telephone company to activate line service and pay for the service and monthly charges.

1. The Lead Contractor shall provide three (3) data/phone jacks in locations indicated on the approved office plan accepted by the Department for use with the Department's computer(s) and Contractor provided phones. The Lead Contractor shall provide a Broadband Internet service and pay all connections/disconnection and monthly fees. The Lead Contractor shall further provide Wi-Fi access utilizing WPA2 security. Options include cable modem, DSL, Satellite or similar service (dial up is not acceptable). The wireless access point should be positioned to provide sufficient coverage in the DGS

Construction Managers Office space. The contractor shall provide usernames/passwords for authorized wireless users as determined by the DGS Construction Project Manager.

2. It shall be the Lead Contractor's responsibility to ascertain the means in which the Broadband Internet source will be provided. Internet download and upload speeds of 100Mbps shall be provided at all times. The Internet source must be coordinated with the DGS Construction Project Manager to assure compatibility with the Department's hardware/software requirements. Wireless access point shall be made fully operational and maintained by the Contractor. At the Department's sole discretion 4G LTE wireless hotspot internet service may be acceptable.

1.23 SANITARY FACILITIES

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

1.24 SMOKING POLICY

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

1.25 CONCRETE AND EARTHWORK

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

1.26 QUALITY CONTROL TESTING

- A. Structural-related testing and inspections required to be performed by the Contractor(s) are listed in Section 014000 – Quality Control Testing Services. If Quality Control testing or inspections required appear in Section 014000 and in a technical section, the most stringent requirements shall prevail. If Quality Control testing or inspections required appear in a technical section and not in Section 014000, they shall be required as if specified in Section 014000. Conditions pertaining to Quality Control testing and inspections may appear in the technical sections. All testing herein is to be by the Contractor. Testing by the Department, Quality Assurance Testing, is for the purpose of checking the results of the Contractor's Quality Control Testing. Testing is to be by the Contractor, unless specifically stated to be "by the Department" or required by Section 014010 – Quality Assurance Testing and Inspection Services.
- B. Non-structural testing is in the technical specifications.

1.27 CADD FILE WAIVER

- A. The Professional will make graphic portions of the bid drawings available for use by the Contractor by uploading files to e-Builder.

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

1.28 DELEGATED DESIGN SERVICES

- A. Performance and Design Criteria: Where design services or certifications by a design professional are specifically delegated to the Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated in the technical specification sections.

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

1.29 COORDINATION DRAWINGS

A. General:

1. Refer to the General Conditions of the Construction Contract regarding the preparation of Coordination Drawings and the responsibilities of all Prime Contractors. Any conflicts between or questions regarding the requirements in this Section and the requirements in the General Conditions should be brought to the attention of the Professional.
2. Refer to Technical Specification sections for specific Coordination Drawing requirements for mechanical and electrical installations. Other Technical Specifications sections may also identify requirements for Coordination Drawings.
3. The Prime Contractors shall indicate the value of this effort as a line item on the Schedule of Values.
4. Submission of Coordination Drawings shall be included as a milestone on the Construction Schedule. The General Contractor shall initiate this action and acquire the necessary dates from the other Prime Contractors as part of their overall scheduling responsibilities.
5. Coordination drawings shall be completed within (60) calendar days of the Effective Date of the Contract.
6. The Department's receipt of Coordination Drawings does not in any way constitute approval, or relieve the Prime Contractors of the responsibility to accurately coordinate and install their work.

B. Coordination Procedures:

1. The HVAC Contractor shall have the lead role in this process and shall initiate Coordination Drawings by producing background drawings in electronic format. Electronic drawing files will be available in e-Builder to all Prime Contractors. These background drawings shall include walls, partitions, structural elements, finished floor elevations, dimensions, ductwork, piping, conduit, system devices, associated equipment, etc.
2. Electronic drawings shall then be forwarded to the other Prime Contractors, one at a time, including the General Contractor, for inclusion, layout and interface of all relative equipment, material and penetrations associated with the Work.
3. Each Prime Contractor is responsible for the accuracy and completeness of all Coordination Drawings and shall review all other Prime Contractor's drawings so that there will be no interference and/or conflict with its portion of the work.
4. Upon completion of the preliminary Coordination Drawings, the HVAC Contractor shall schedule a coordination meeting with all Prime Contractors in order to resolve all interference issues. Altering structural elements, bearing elevations, established dimensions, partition locations and ceiling/bulkhead heights or any other aesthetic effect is prohibited without the consent of the Professional.

5. Upon resolution of all interference issues, the Coordination Drawings shall be revised as required, and upon acceptance by all Prime Contractors, the HVAC Contractor will upload the final Coordination Drawings to e-Builder.
 - a. Coordination Drawings shall contain a signature block for each Prime Contractor to provide signatures and dates indicating concurrence.
6. Coordination Drawings may be formulated and submitted in partial submittals to facilitate the construction schedule and sequence of work within the Project. This must be agreed to by all Prime Contractors and a priority of sequence must be established that has the concurrence of all parties, including the Department. Approval of partial sets of Coordination Drawings shall not relieve the Contractors of their responsibility for properly coordinating work appearing in subsequent submissions. Any revisions to subsequent work necessitated by such partial approvals shall be performed at no additional cost to the Department.

C. Coordination of Work:

1. Each Prime Contractor shall clearly show, and coordinate with the other Prime Contractors, the following:
 - a. Arrange for pipe spaces, chases, slots, sleeves, and openings with general construction work, and arrange in building structure during progress of the Work, to allow for and facilitate distribution line and equipment installation.
 - b. Coordinate installation of required supporting devices for ductwork, piping, and conduit, as well as sleeves, and other structural components, as they are constructed.
 - c. Coordinate requirements for access panels and doors for HVAC, Plumbing and Electrical items requiring access where concealed behind finished surfaces.
 - d. Coordinate electrical connections to equipment provided by all Contractors.
 - e. Sequence, coordinate, and integrate installing materials and equipment for efficient flow of the Work. Coordinate installing large items of equipment requiring positioning before closing in the building.
2. Each Prime Contractor shall coordinate its construction operations with those of other Prime Contractors and entities to ensure efficient and orderly installation for each part of the Work. Each Prime Contractor shall coordinate its operations with other operations, included in different Sections that depend on each other for proper installations, connection, and operation. All Prime Contractors shall:
 - a. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - b. Coordinate installation of all components with other Prime Contractors to ensure adequate accessibility/clearance for required maintenance and service.
 - c. Make provisions to accommodate items scheduled for later installation.

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. Mobilization
- b. Prepare submittals and shop drawings
- c. Material orders for long lead items after submittal approval
- d. Earthwork and utilities
- e. Foundations
- f. Structure
- g. Building enclosure
- h. Building finishes
- i. Site work
- j. Punch list
- k. Project Close-out

- 2. HVAC Construction (.2) Contract:

- a. Mobilization and on-site Staging.
- b. Prepare submittals and shop drawings.
- c. Construction Staging and Traffic Plan-coordinated with other Prime Contracts.
- d. Temporary Services and Utility Plan.
- e. Install Temporary Utilities.
- f. Prepare coordination drawings.

- g. Equipment orders for long lead items after submittal approval.
 - h. First floor ductwork.
 - i. Equipment installations.
 - j. Controls installation.
 - k. Testing and Balancing.
 - l. Punch list.
 - m. Project Close-out.
3. Plumbing Construction (.3) Contract:
- a. Mobilization and on-site Staging.
 - b. Prepare submittals and shop drawings.
 - c. Construction Staging and Traffic Plan-coordinated with other Prime Contracts.
 - d. Temporary Services and Utility Plan.
 - e. Install Temporary Utilities.
 - f. Prepare coordination drawings.
 - g. Temporary Service Plan.
 - h. Equipment orders for long lead items after submittal approval.
 - i. Subgrade piping installation.
 - j. First floor piping and rough-ins.
 - k. Equipment installations.
 - l. Fixture installation.
 - m. Punch list.
 - n. Project Close-out.
4. Electrical Construction (.4) Contract:
- a. Mobilization and on-site Staging.
 - b. Prepare submittals and shop drawings.
 - c. Construction Staging and Traffic Plan-coordinated with other Prime Contracts.
 - d. Temporary Protection Plan.
 - e. Temporary Services and Utility Plan.
 - f. Install Temporary Utilities.
 - g. Permanent Primary Electrical Service Installation including Primary Service Transformer.
 - h. Prepare coordination drawings.
 - i. Equipment orders for long lead items after submittal approval.
 - j. Permanent Electrical Service Distribution Installation including subgrade installations to new facilities.
 - k. First floor rough-ins.
 - l. Equipment installations.
 - m. Device and fixture installation.
 - n. Punch list.
 - o. Project Close-out.

1.5 SEQUENCING OF CONSTRUCTION AND OTHER REQUIREMENTS

- A. For Loop C and Organized Group Camp- Camp Daddy Allen and Camp Shehaqua, the sequence of construction must allow for the existing shower buildings to remain operational and safely accessible by the public until the new buildings are complete, open, and safely accessible by the public. The contractor shall provide all necessary fencing, signage, and other safety devices to separate and isolate public accessible areas from work areas and ensure

continued and safe access by the public to the existing and new facilities. All work areas shall be secured from public access during non-work hours.

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
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
Field Density of Soil and Soil-Aggregate In Place by Sand Cone Method or Rubber Balloon Method	ASTM D1556 (sand cone method) ASTM D2167 (rubber balloon method)	As often as required to ensure contract compliance
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
Testing of composite samples of fresh concrete	ASTM C172	Obtain at least one composite sample for each 100 cu. yd. or 5000 sq. ft. or fraction thereof of each concrete mixture placed each day
Testing of composite samples of fresh concrete: 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.
Testing of composite samples of fresh concrete: air content	ASTM C 231, pressure method	One test for each composite sample, but not less than one test for each day's pour of each concrete mixture
Testing of composite samples of fresh concrete: concrete temperature	ASTM C1064/C1064M	One test hourly when air temperature is 40 deg F (4.4 deg C) and below and when it is 80 deg F (27 deg C) and above, and one test for each composite sample
Testing of composite samples of fresh concrete: compression test specimens	ASTM C31/C31M	Cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
Testing of composite samples of fresh concrete: Compressive-strength tests	ASTM C39/C39M	Test one specimen at seven days and two specimens at 28 days.
Inspection of measuring, mixing, transporting, and placing.	ACI 301	Continuous
Verification of slump flow and VSI as delivered to the site for self-consolidating grout	ACI 530	Structural should confirm, otherwise would keep for DD. Continuous
MASONRY		
Constructing and Testing Masonry Prisms Used to Determine Compliance with Specified Compressive Strength of Masonry (3 prisms/test)	ASTM C1314	1 Test

DESCRIPTION OF TEST OR INSPECTION	REFERENCED STANDARD	QUANTITY OR FREQUENCY
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 radiographic method [<i>to be specified by structural engineer herein</i>]
Guide for Magnetic Particle Examination	<i>ASTM E709</i>	
Practice for Ultrasonic Contact Examination of Weldments	ASTM E164	
Guide for Radiographic Examination	ASTM E94	
WATER UTILITY DISTRIBUTION PIPING		
Inspection of proper installation of water mains, complete with fittings, valves, thrust blocks, harnessing, connections, and appurtenances	AWWA C900	Continuous
Inspection of testing and disinfection of water mains	AWWA C600 and C601	One per each water main installation
SANITARY UTILITY SEWERAGE PIPING		
Vacuum testing precast concrete manholes	ASTM C1244	Once a manhole is installed, prior to backfill
Leakage Testing sewer pipe	ASTM F1417	Each section of pipe, manhole to manhole

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.

List of tests below will be reviewed, edited, and coordinated during the Construction Documents phase of design.

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		
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 anchors installed in hardened concrete	ACI 318: 3.8.6, 8.1.3, 21.2.8	1912.1
IBC	4. Verifying use of required design mix	ACI 318: Ch. 4, 5.2-5.4	1904.22, 1913.2, 1913.3
IBC	5. 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	6. Inspection for maintenance of specified curing temperature and techniques	ACI 318; 5.11-5.13	1913.9
DGS	Review Contractors' design mixes, Certificates of Compliance and material test reports		
DGS	Compressive Strength of Cylindrical Concrete Specimens ²	ASTM C39	
	MASONRY		
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 1 Special Inspection		

<u>REQ'D BY¹</u>	<u>DESCRIPTION OF TEST OR INSPECTION</u>	<u>REFERENCED STANDARD</u>	<u>IBC REFER-ENCE²</u>
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 except where specifically exempted by this code.	Art. 1.4B ⁵	
IBC	3. Verification of slump flow and VSI as delivered to the site for self-consolidating grout.	Art. 1.5B.1.b.3 ⁵	
IBC	4. As masonry construction begins, the following shall be verified to ensure compliance: a. Proportions of site-prepared mortar b. Construction of mortar joint c. Location of reinforcement connectors, prestressing tendons and anchorages d. Prestressing technique e. Grade and size of prestressing tendons and anchorages	Art 2.6A ⁵ Art 3.3B ⁵ Art 3.4, 3.6A ⁵ Art 3.6B ⁵ Art 2.4B, 2.4H ⁵	
IBC	5. The inspection program shall verify: a. Size and location of structural elements b. Type, size and location of anchors, including other details of anchorage of masonry to structural members, frames or other construction. c. Specified size, grade and type of reinforcement, anchor bolts, prestressing tendons and anchorages. d. Welding of reinforcing bars e. Preparation, construction and protection of masonry during cold weather (temperature below 40°F) or hot weather (temperature above 90°F) f. Application and measurement of prestressing force	Art 3.3F ⁵ Sec 1.2.2(e) ⁴ , 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, 1.8D ⁵ Art 3.6B ⁵	Sec 2104.3, 2104.4
IBC	6. Prior to grouting, the following shall be verified to ensure compliance: a. Grout space is clean b. Placement of reinforcement and connectors and prestressing tendons and anchorages c. Proportions of site-prepared grout and prestressing grout for bonded tendons d. Construction of mortar joints	Art 3.2D ⁵ Sec 1.13 ⁴ , Art 3.4 ⁵ Art 2.6B ⁵ Art 3.3B ⁵	
IBC	7. Preparation of any required grout specimens, mortar specimens and/or prisms shall be observed	Art 1.4 ⁵	Sec 2105.2.2, 2105.3
IBC	8. Preparation of any required grout specimens, mortar specimens and/or prisms shall be observed		
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	

<u>REQ'D BY¹</u>	<u>DESCRIPTION OF TEST OR INSPECTION</u>	<u>REFERENCED STANDARD</u>	<u>IBC REFER-ENCE²</u>
	WOOD		
IBC	Professional to determine requirements.		1704.2, 1704.6
	EXTERIOR INSULATION AND FINISH SYSTEMS		
IBC	Professional to determine requirements.		1704.14
	GENERAL OVERVIEW OF QC TESTING		
DGS	Review of Contractor QC Testing and Reports		

SECTION 2

<u>REQ'D 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>REQ D BY</u> ¹	<u>DESCRIPTION OF TEST OR INSPECTION</u>	<u>REFERENCED STANDARD</u>	<u>IBC REFER- ENCE</u> ²
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.
- E. In addition to all requirements of this section, existing Park facilities indicated for demolition under this project must remain in operation and safely accessible by the public during construction, until new adjacent facilities are open and safely accessible by the public. All temporary or relocated utilities required for this purpose shall be provided by the appropriate Contractor(s). This includes, but is not limited to, uninterrupted propane service to the existing building at Camp Shehaqua.

1.3 TEMPORARY WATER SUPPLY

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

- 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. The HVAC Contractor may, with the Department's and Client Agency's approval, utilize the permanent system or portions thereof, or may install temporary steam or hot water radiation or convectors or a combination of both. The HVAC Contractor shall operate portable steam or hot water generating equipment for supply to permanent or temporary building heating facilities
- E. Temporary heating system, as hereinafter noted, shall be of sufficient capacity to heat the interior of the building to 60⁰F when outside temperature is 0⁰F. The interior temperature must be 60⁰F or above at all times. This service shall be continued until the entire Project is completed, except as hereinafter noted.
- F. Where electricians or plumbers are required to install, operate supervise or maintain equipment used in the provisions of temporary heat, the payment of the services of such material and personnel shall be the responsibility of the Electrical and the Plumbing Contractors respectively. It will be the responsibility of the Electrical and Plumbing Contractors to coordinate with the HVAC Contractor for temporary heat.
- G. The Lead Contractor shall pay for all fuel and electricity for the temporary heat in conjunction with the operation of heating equipment for enclosed buildings, or enclosed portions thereof, unless provided by the Client Agency as noted above.
- H. The Lead Contractor shall remove normal soot, smudges, and other deposits from walls, ceilings and exposed surfaces which are the result of the use of any temporary heating equipment after enclosure, including the use of the permanent heating system for temporary heating purposes. Finish work shall not start until all such surfaces are properly cleaned. Soot, etc. caused by equipment malfunction shall be removed by the responsible Contractor. Each Prime Contractor shall correct/replace any of their respective work that is identified by the Department or Professional as not meeting the project specifications as a result of the failure of any Prime Contractor to maintain or provide appropriate temporary heat, cooling,

dehumidification, or ventilation in accordance with the contract requirements or the manufactures requirements. Each Prime Contractor will follow the requirements of the General Conditions regarding any disputes due to another Prime Contractor's failure to provide or maintain proper temporary heating, cooling, dehumidification, or ventilation of the conditioned space. Each Prime Contractor shall correct/replace any of their respective work that does not meet Contract requirements due to use of temporary heat.

- I. All permanent heating equipment used to supply temporary heat shall be completely cleaned and reconditioned by the HVAC Contractor, in the presence of the Department personnel, prior to Final Acceptance. Cleaning of permanent HVAC ducts utilized for temporary heat shall be required. The HVAC Contractor should filter the return air at grilles, and wherever necessary to prevent dust accumulation. All permanent heating equipment, such as radiator trap seats and diaphragms, valve sets and discs, strainer internals or any other equipment found to be damaged due to being used for temporary heat shall be replaced. All replacements must be inspected by the Professional and accepted by the Department personnel. The HVAC Contractor shall pay for all replacement parts and labor.
- J. The cost of temporary heat shall be made a part of the lump sum bid submitted by each Contractor, as applicable. The cost of temporary heat after enclosure shall be shown on the Contract Schedule of Values, to include the number of calendar days, cost per twenty-four (24) hour day and extended price. Any adjustment to the number of days of temporary heat, used or not used, may be based on this unit price. Each Contractor shall include ~~/xxx/~~ calendar days of temporary heat after building enclosure, in its bid.
- K. Temporary Ventilation and Temperature Control: The Lead Contractor shall provide electronic daily temperature/humidity readings equipment and log the conditions throughout the building to assure the proper and adequate temperature/humidity levels are recorded and maintained. The Lead Contractor shall provide the appropriate temporary ventilation, dehumidification, humidification or cooling equipment to assure the interior humidity/temperature levels are provided to meet all building finish requirements in accordance with the manufacture requirements.

1.5 CONSTRUCTION LIGHT AND POWER

- A. The Electrical Contractor shall install, operate, protect and maintain the temporary service for construction light and power. The Contractor shall extend the temporary wiring throughout the project work areas, properly insulated and installed in accordance with Article 300 of the National Electrical Code. All wiring shall be installed by a licensed electrician.
- B. The Electrical Contractor shall furnish this service within fifteen (15) days of any Prime Contractor's written request for such services. The service shall be sized to satisfy project requirements, but shall not be less than 200 amp, single-phase, 3-wire 120/240 volts, with fused safety switch protection required. Additional capacity in the form of other independent services and panels shall be provided as needed at required location throughout the site to meet the requirements of this section.
- C. The Electrical Contractor shall extend electrical wiring into the building to provide adequate light and power, for the proper execution of the work. The Electrical Contractor shall also provide three-phase, 208 volt power service, if required. As construction progresses, it shall extend the temporary services to all areas where required, with a minimum of 100W incandescent equivalent light and duplex power outlets at 20 feet on center minimum, and at least in every room or space. The maximum size motor to be used at any power service shall be limited to 5 hp. Construction light and power provided shall fully comply with all provisions for this service of the National Electric Code and OSHA.

- D. Where a service of a type other than that as herein mentioned is required, each Contractor requiring same shall provide such service and necessary equipment at its own expense.
- E. The Electrical Contractor, prior to the installation of the permanent service, shall provide portable generators or shall extend a temporary service line to the site, and shall sign for the meter and pay all electrical connection costs.
- F. The Electrical Contractor shall provide all transformers necessary to provide temporary power.
- G. The Electrical Contractor shall provide all meters and/or submeters required and necessary to meter usage.
- H. The Lead Contractor shall pay all electric consumption and associated costs for its use and that of all Prime Contractors, until Closeout Inspection occurs, and all items of work are certified to be complete.

1.6 WELDING

- A. Any Contractor using electrical power for welding on the site shall use self-contained engine generating units.
- B. Each Contractor shall provide necessary exhaust/ventilation/filtration to prevent accumulation of welding fumes and smoke generated by welding their operations.
- C. Each Contractor shall have all precautions and protection in place while welding to assure no sparks cause fire or smoke damage to all surrounding areas; during and after all welding activities.

1.7 FIRE EXTINGUISHERS

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

1.8 INTERRUPTION OF SERVICES

- A. Each Prime Contractor shall have all needed equipment and material to complete planned work at the site, prior to shutting down any system.
- B. No additional compensation or time will be given to the Contractor, if work must be performed on State or National Holidays or on weekends or on overtime. See paragraph on 'Working Hours' under Section 010400.
- C. Utility interruptions to occupied and available camping areas are only to occur outside of camping season and requires approval in advance.

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

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 015639

TREE PROTECTION AND TRIMMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawing and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section
- B. See Section 311000, Site Clearing.

1.2 DESCRIPTION

- A. This Section includes the protection and trimming of trees that interfere with, or are affected by, execution of the building expansion and renovation.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Tree Pruning Schedule: Written schedule from arborist detailing scope and extent of pruning of trees to remain that interfere with or affected by construction.
- C. Qualification Data: For tree service firm and arborist, if required.
- D. Certification: From arborist, certifying that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.
- E. Maintenance Recommendations: From qualified arborist, for care and protection of trees affected by construction during and after completion of the Work.

1.4 QUALITY ASSURANCE

- A. Tree Service Qualifications: An experienced tree service firm that has successfully completed tree protection and trimming work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site on a full-time basis during excavation of the Work.
- B. Arborist qualifications: An arborist certified by the International Society of Arboriculture or licensed in the jurisdiction where Project is located.
- C. Tree Pruning Standards: Comply with ANSI A300 (Part 1), "Trees, Shrubs, and other Woody Plant Maintenance—Standard Practices (Pruning)."
- D. Pre-installation Conference: Before starting tree protection and trimming, meet with representatives of authorities having jurisdiction, Client Agency, Professional, consultants, and other concerned entities to review tree protection and trimming procedures and responsibilities.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Temporary Tree Protection Fence: Wood and wire snow fence, steel posts and other accessories for a complete fence system.
- B. Post sizes and material: As shown on Contract Drawings.
- C. Temporary Signs: White or yellow weatherproof material, 8 inch by 40 inch minimum, with 3-inch black lettering; text- "Keep Out: Tree Protection Area"
- D. Organic Mulch: Shredded or chipped wood and bark, free of deleterious materials. Chipped material from tree pruning operations may be used.
- E. Geotextile Fabric: Manufacturer's standard, nonwoven, pervious geotextile fabric of polypropylene, nylon, or polyester fibers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Temporary Fencing: Install temporary fencing around the tree protection zones to protect remaining vegetation from construction damage. Maintain temporary fence and remove when construction is complete.
- B. Temporary Signs: Install temporary signs 60 feet apart, or two per protected tree, whichever is greater, on posts of temporary fencing. Maintain temporary signs and remove when construction is complete.
- C. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.
 - 1. Install Geotextile fabric and organic mulch in areas within drip line of trees to remain and other areas indicated. Install geotextile fabric.
 - 2. Place 4-inch average thickness of organic mulch on top of wood log mats and fabric.
- D. Install geotextile fabric and organic mulch in areas inside tree protection zones and other areas indicated.
 - 1. Install geotextile fabric.
 - 2. Apply 4-inch average thickness of mulch. Do not place mulch within 6 inches of tree trunks.

- E. Do not store construction materials, debris, or excavated material inside tree protection zones. Do not permit vehicles or foot traffic within tree protection zones; prevent soil compaction over root systems.
- F. Do not allow fires within tree protection zone.

3.2 EXCAVATION

- A. Install shoring or other protective support systems to minimize shoring or benching of excavations.
- B. Do not excavate within tree protection zones, unless otherwise indicated.
- C. Where utility trenches are required within tree protection zones, tunnel under or around roots by using an air spade.
- D. Root Pruning: Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots with sharp pruning instruments; do not break or chop.
- E. When trenching, place excavated soil on opposite side of trench from tree.

3.3 TREE PRUNING

- A. Prune trees to remain that are affected by temporary and permanent construction.
- B. Pruning Standards: Prune trees according to ANSI A300 (Part 1).
- C. Cut branches with sharp pruning instruments; do not break or chop.
- D. Chip removed tree branches and uses as organic mulch or dispose of off-site.

3.4 TREE REPAIR AND REPLACEMENT

- A. Promptly repair trees damaged by construction operations within 24 hours. Treat damaged trunks, limbs, and roots according to arborist's written instructions.
- B. Remove and replace dead and damaged trees that arborist determines to be incapable of restoring to a normal growth pattern.
 - 1. Provide new trees of a 6-inch caliber size and of a species selected by Professional when damaged trees more than 6-inch caliber size, measured 12 inches above grade, are required to be replaced.
 - a. Planting New Trees: Comply with Columbia University standards.
 - b. Warranty and Maintenance Period: One year.

3.5 DISPOSAL OF WASTE MATERIALS

- A. Burning is not permitted.

- B. Disposal: Remove excess excavated material, displaced trees, and excess chips from Client Agency's property. Disposal shall be in a legal manner.

END OF SECTION 015639

SECTION 015713

TEMPORARY EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The work of this section includes all temporary erosion and sediment control and related and incidental operations, including:
 - 1. Compost Sock installation and maintenance
 - 2. Erosion Control Blanket installation and maintenance
 - 3. Rock Construction Entrance
 - 4. Maintenance and repairs of erosion and sediment control measures
 - 5. Temporary seeding
 - 6. Pumped Water Filter Bag
- B. Related Sections:
 - 1. Section 311000, "Site Clearing".
 - 2. Section 312000, "Earth Moving".
 - 3. Section 015639, "Temporary Tree and Plant Protection."

1.3 REFERENCES

- A. Work and materials shall conform to the latest editions of the following standards:
 - 1. Pennsylvania Code, Chapter 102, Erosion and Sediment Control.
 - 2. Pennsylvania Department of Environmental Protection, Erosion and Sediment Pollution Control Manual, latest edition.
 - 3. PennDOT Pub. 408, Latest Edition.

1.4 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts 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, 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.

1.5 SUBMITTALS

- A. Material Test Reports: Stone, Rip Rap, and all other aggregates.
- B. Cut Sheets and/or Product Data: Manufactured Products

PART 2 - MATERIALS

- 2.1 All materials and products shall meet the approval of the professional. Cut sheets for all items shall be submitted for review and approval prior to installation.
 - A. Geotextile – Class 4 Type A as specified by Pennsylvania Department of Transportation Publication 408, Section 735.
 - B. Stone for Rip Rap - As specified in Pennsylvania Department of Transportation Publication 408, Section 850 and 851.
 - C. Erosion Control Blanket –Only 100% biodegradable non-plastic materials acceptable. No erosion control blanket with polypropylene, nylon, polyethylene, and polyester will be accepted. Erosion control blanket shall meet the specifications of PennDOT Publication Section 806 Table B for Double Net Erosion Control Blanket. Removal will be at Contractor’s expense at no cost to the Department. No synthetic materials shall be used.
 - 1. BioNet® C125BN® Long-Term Biodegradable Double-Net Coconut Blanket by North American Green or
 - 2. East Coast Erosion Control ECSC-2B Double Net Straw Biodegradable Rolled Erosion Control Product or
 - 3. AEC PREMIER STRAW/COCONUT™ FIBRENET or equal as approved by the professional.
 - D. Compost Socks – 12”-32” diameter Heavy Duty Multi-Filament Polypropylene (HDMFPP) for a minimum functional longevity of 2 years as specified by Pennsylvania Department of Transportation Publication 867, Section 867. See plans for sizing.
 - E. Inlet Protection - Woven polypropylene fabric bag sized to fit inlet or structure conforming to PennDOT Section 860.
 - F. Construction Rock Entrance shall be as indicated on plans and details per Pennsylvania Department of Transportation Publication 408, Section 849.
 - 1. Rock - AASHTO #1 and conform to PennDOT Section 703.2 Type A or C.
 - 2. Geotextile – Class 4 Type A.
 - G. Pumped water filter bags - Nonwoven geotextile fabric bag that collects silt from pumped water conforming to PennDOT 855.

- H. Timber Matting – Meeting design properties of ASTM 5456.
 - 1. Mixed Hardwoods.
 - 2. Hardware Grade A36 or higher.
 - 3. Geotextile underlayment
- I. Seed Types shall be as indicated on contract drawings.
- J. Mulch & Temp Seed – See plans for temporary seeding table. All products incidental to temporary seeding shall conform to PennDOT Publication 408 Section 804 and 805.
- K. Construction fence and gates shall be six foot galvanized chain link fence.
- L.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS:

- A. All temporary erosion and sediment control measures indicated on the drawings and specified herein shall be in place before the beginning of any earthwork or site work phase.
- B. It is the CONTRACTOR'S responsibility to maintain, replace, operate, and coordinate staged installation of temporary erosion and sediment control measures in order to prevent accelerated erosion and the discharge of sediment laden waters from the site.
- C. Maintenance of the erosion and sediment control measures shall include inspection after each storm event and on a weekly basis, logging condition of measures, and cleaning, repairing, and/or replacing measures promptly and as needed.
- D. Erosion and sediment control measures shall be inspected weekly and after every precipitation event. A written maintenance report must be kept at the site during construction. It is the responsibility of the site contractor to ensure that this Operation & Maintenance schedule be maintained and logged.
- E. Erosion Control Blanket
 - 1. Prepare final graded and dressed soil surfaces to receive seeding as specified.
 - 2. Place designated seed formula mixture as specified
 - 3. Unroll, place, and anchor the ECB evenly and smoothly without stretching. Use appropriate anchoring devices and follow installation directions of manufacturer. Drive staples or anchoring pins flush with soil surface.
- F. Rock Construction Entrance
 - 1. Clear and grub the footprint of the entrance.
 - 2. Construct entrance by excavating.
 - 3. Place geotextile.
 - 4. Install stone.
 - 5. Add additional stone to satisfactorily maintain entrance. Remove sediment from entrance regularly.

G. Inlet Protection

1. Install bag per manufacturer's recommendations.
2. Replace or remove and clean bag when 1/3 full of sediment.

H. Compost Filter Sock

1. Install compost sock and inlet protection according to manufacturer's directions.
2. Place compost filter sock downslope of disturbance and on a level contour.
3. Extend both ends 8 ft. upslope at 45 degrees.
4. Anchor compost filter sock with stakes at 10 ft. intervals.
5. Maintain until the end of the contract.

I. Remove (or spread) compost sock upon project completion and ground stabilization.

J. All graded or cleared areas shall receive temporary seeding if subject to erosion for a period of 72 hours or more. See Part 3.10 of Section 312000, Earth Moving.

1. Prepare area to be seeded by hand raking and grading prior to seeding.
2. Mulch newly seeded areas to prevent erosion prior to seed germination and stabilization.
3. Seeding shall be at 1 ton per acre (40 lbs. per 1000 square feet).

K. Provide adequate maintenance conforming to requirements of the Client Agency and Kidder Township.

L. Remove sediment from compost socks, inlet protections, and pavement areas after each major storm event.

END OF SECTION 015713

SECTION 017419

CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Salvaging nonhazardous demolition and construction waste.
 - 2. Recycling nonhazardous demolition and construction waste.
 - 3. Disposing of nonhazardous demolition and construction waste.

1.3 DEFINITIONS

- A. Construction Waste: Building, structure, and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building, structure, and site improvement materials resulting from demolition operations.
- C. Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on Department’s property.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
- E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.4 ACTION SUBMITTALS

- A. Waste Management Plan: Submit plan within 7 days of date established for commencement of the Work.

1.5 INFORMATIONAL SUBMITTALS

- A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Include the following information:
 - 1. Material category.
 - 2. Generation point of waste.
 - 3. Total quantity of waste in tons (tonnes).
 - 4. Quantity of waste salvaged, both estimated and actual in tons (tonnes).
 - 5. Quantity of waste recycled, both estimated and actual in tons (tonnes).
 - 6. Total quantity of waste recovered (salvaged plus recycled) in tons (tonnes).
 - 7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.
- B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.
- C. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.
- D. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.
- E. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
- F. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

1.6 QUALITY ASSURANCE

- A. Waste Management Coordinator Qualifications: Experienced firm, or individual employed and assigned by General Contractor, with a record of successful waste management coordination of projects with similar requirements.
- B. Waste Management Conference(s): Conduct conference(s) at Project site to comply with requirements in Section 013100 "Project Management and Coordination."

1.7 WASTE MANAGEMENT PLAN

- A. General: Develop a waste management plan according to requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Distinguish between demolition and construction waste. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.

- B. Waste Identification: Indicate anticipated types and quantities of demolition, site-clearing, and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.
- C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.
 - 1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
 - 2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
 - 3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
 - 4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
 - 5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
 - 6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: Achieve end-of-Project rates for salvage/recycling of 85 percent by weight of total nonhazardous solid waste generated by the Work. Facilitate recycling and salvage of materials.

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
- B. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.
 - 1. Distribute waste management plan to everyone concerned.
 - 2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

- C. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

3.2 SALVAGING DEMOLITION WASTE

- A. Comply with requirements in Section 024116 "Structure Demolition" for salvaging demolition waste.
- B. Salvaged Items for Reuse in the Work:
 - 1. Clean salvaged items.
 - 2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
 - 3. Store items in a secure area until installation.
 - 4. Protect items from damage during transport and storage.
 - 5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.
- C. Salvaged Items for Sale and Donation: Not permitted on Project site.
- D. Salvaged Items for Department's Use:
 - 1. Clean salvaged items.
 - 2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
 - 3. Store items in a secure area until delivery to Department.
 - 4. Transport items to Department 's storage area designated by Department.
 - 5. Protect items from damage during transport and storage.

3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

- A. General: Recycle paper and beverage containers used by on-site workers.
- B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.
- C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.
- D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.
 - 1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.

- a. Inspect containers and bins for contamination and remove contaminated materials if found.
2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
4. Store components off the ground and protect from the weather.
5. Remove recyclable waste from Department's property and transport to recycling receiver or processor as often as required to prevent overfilling bins.

3.4 RECYCLING DEMOLITION WASTE

- A. Asphalt Paving: Break up and transport paving to asphalt-recycling facility.
- B. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.
 1. Pulverize concrete as required to recycle.
- C. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.
 1. Clean and stack undamaged, whole masonry units on wood pallets.
- D. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.
- E. Metals: Separate metals by type.
 1. Structural Steel: Stack members according to size, type of member, and length.
 2. Remove and dispose of bolts, nuts, washers, and other rough hardware.
- F. Asphalt Shingle Roofing: Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.
- G. Piping: Reduce piping to straight lengths and store by material and size. Separate supports, hangers, valves, sprinklers, and other components by material and size.
- H. Conduit: Reduce conduit to straight lengths and store by material and size.
- I. Lamps: Separate lamps by type and store according to requirements in 40 CFR 273.

3.5 RECYCLING CONSTRUCTION WASTE

- A. Packaging:
 1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
 2. Polystyrene Packaging: Separate and bag materials.

3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Wood Materials:

1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

C. Paint: Seal containers and store by type.

3.6 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged or recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. General: Except for items or materials to be salvaged or recycled, remove waste materials and legally dispose of at designated spoil areas on Department's property.

C. Burning: Do not burn waste materials.

END OF SECTION 017419

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 SUMMARY

- A. Section Includes:
 - 1. Demolition and removal of buildings and site improvements.
 - 2. Removing below-grade construction.
 - 3. Disconnecting, capping or sealing, abandoning in-place, and removing site utilities.
 - 4. Salvaging items for reuse by Client Agency.

1.3 DEFINITIONS

- A. Demolish: Completely remove and legally dispose of off-site.
- B. Recycle: Recovery of demolition waste for subsequent processing in preparation for reuse.

1.4 MATERIALS OWNERSHIP

- A. All demolition waste remains the property of the Client Agency until reviewed by the Client Agency representative and is identified as of no value to the Client Agency, at which time it becomes property of Contractor.
 - 1. Salvage property identified as valuable and protect as directed by Client Agency representative.
 - 2. Store items in a secure area until delivery to the Client Agency.
 - 3. Transport items to the Client Agency's storage area designated by the Client Agency.
- 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 Client Agency that may be uncovered during demolition remain the property of Client Agency.
 - 1. Carefully salvage in a manner to prevent damage and promptly return to Client Agency.

1.5 PREINSTALLATION MEETINGS

- A. Pre-demolition Conference: Conduct conference at Project site.

1.6 INFORMATIONAL SUBMITTALS

- A. 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.
- B. Schedule of building demolition activities with starting and ending dates for each activity.

1.7 CLOSEOUT SUBMITTALS

- A. Inventory of items that have been removed and salvaged.
 - 1. Protect items from damage during transport and storage.

1.8 FIELD CONDITIONS

- A. Buildings to be demolished will be vacated and their use discontinued before start of the Work.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Client Agency as far as practical.
- C. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - 1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Professional and Client Agency. Hazardous materials will be removed by Client Agency under a separate contract.
- D. On-site storage or sale of removed items or materials is not permitted.
- E. Arrange demolition schedule so as not to interfere with Client Agency's on-site operations.

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/ASSE 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. 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.
- C. Inventory and record the condition of items to be removed and salvaged.

3.2 PREPARATION

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.
- B. Salvaged Items: Comply with the following:
 - 1. Clean salvaged items of dirt and demolition debris.
 - 2. Pack or crate items after cleaning. Identify contents of containers.
 - 3. Store items in a secure area until delivery to Client Agency.
 - 4. Transport items to storage area designated by Client Agency.
 - 5. Protect items from damage during transport and storage.
- C. Waste vaults: Contractor is responsible for pumping of waste vaults prior to demolition.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Utilities to be Disconnected: Locate, identify, disconnect, and seal or cap off utilities serving buildings and structures to be demolished.
 - 1. Client Agency will arrange to shut off utilities when requested by Contractor.
 - 2. Arrange to shut off utilities with utility companies.
 - 3. If removal, relocation, or abandonment 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.
 - 4. Remove electric conductors back to the service that feeds them. No wires are to be left in conduit.
 - 5. Cut off pipe or conduit a minimum of 24 inches (610 mm) below grade. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing according to requirements of authorities having jurisdiction.
 - 6. Completely remove gas piping.

7. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing.

3.4 PROTECTION

- 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.
- C. Existing Utilities to Remain: Maintain utility services to remain and protect from damage during demolition operations. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by Client Agency and authorities having jurisdiction.
- D. 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. Demolition areas must be fenced and left safe at the end of the day during demolition activities.
 7. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to building demolition operations.
 8. Erect and maintain dustproof partitions and temporary enclosures to limit dust, noise, and dirt migration to occupied portions of adjacent buildings.
- E. Remove temporary barriers and protections where hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

3.5 DEMOLITION

- A. General: Demolish indicated buildings and site improvements completely. Use methods required to complete the Work within limitations of governing regulations and as follows:
 1. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
 2. Maintain fire watch during and for at least two hours after flame-cutting operations.
 3. Maintain adequate ventilation when using cutting torches.

4. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
- B. 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 Client Agency and authorities having jurisdiction. Provide alternate 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.
 - C. Explosives: Use of explosives is not permitted.
 - D. 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.
 - E. Salvage: Items to be removed and salvaged are indicated in Division 01 Section "Construction Waste Management And Disposal"
 - F. Demolish foundation walls and other below-grade construction.
 1. Remove below-grade construction, including basements, foundation walls, and footings, completely.
 - G. Existing Utilities: As indicated on Drawings, demolish or abandon existing utilities and below-grade utility structures that are within 5 feet (1.5 m) outside footprint indicated for new construction. Abandon utilities outside this area.
 - H. Below-Grade Areas: Completely fill below-grade areas and voids resulting from building demolition operations with satisfactory soil materials according to backfill requirements in Section 312000 "Earth Moving."
 - I. 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.
- 3.6 CLEANING
- A. Remove demolition waste materials from Project site and recycle or dispose of them according to Section 017419 "Construction Waste Management and Disposal."
 - B. Do not burn demolished materials.
 - C. 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.

END OF SECTION 024116

SECTION 031000

CONCRETE FORMWORK

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 DESCRIPTION OF WORK

- A. This Section covers the requirements for designing, furnishing materials for, constructing and removing formwork for cast-in-place concrete.

1.4 RELATED SECTIONS

- A. Section 014000 - Quality Requirements
- B. Section 032000 - Concrete Reinforcement
- C. Section 033000 - Cast-in-place Concrete
- D. Section 055000 - Metal Fabrications

1.5 STANDARDS

- A. American Concrete Institute (ACI)
 - 301 Specifications for Structural concrete for Buildings, Chapter 4, Formwork.
 - 347 Recommended Practice for Concrete Formwork
- B. American Plywood Institute (API)
 - PS 1U.S. Products Standards for Construction and Industrial Plywood

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Formwork

1. Exterior type plywood with one surface providing specified finish sealed to prevent absorption of water from the concrete.
2. Fiber tubular forms to be spirally constructed of laminated plies of fiber. Wall thickness as recommended by the manufacturer to meet load requirements of the various uses and size. Forms to have a wax coated outside surface for moisture resistance. Inside surface to be coated with a bond-breaker compound. Forms to be fabricated in such a manner that finish concrete surfaces will be smooth and free of spiral and seam markings.
3. Ties factory-fabricated, form snap-off metal type, of required design to minimize form deflection and preclude concrete spalling upon removal. Ties to be fabricated so that set-back in the concrete is such that the portion of the tie remaining after snap-off and removal of the exterior portions is at least two inches back from the concrete surface. Maximum diameter of spreader cones on tie wires: 7/8 inch.
4. Breaker non-staining, bond free of mineral oils and other non-drying ingredients. Bond breaker material to leave no bond-inhibiting residues on concrete. Material to be compatible with paint systems, water-repellent coatings or other indicated surface treatments.
5. Strips to be triangular fillets chamfer, milled from clear, straight-grain wood, surfaced each side or extruded vinyl type.
6. Templates for catenary structures and anchors to be constructed of 1/8" minimum steel plate including cut outs for feeder conduits as indicated in the Contract Documents.

B. Form Sealer

1. Provide form sealer compatible with forms type used in installation.

PART 3 - EXECUTION

3.1 CONSTRUCTION

A. General

1. Construct forms consistent with the required strength and finish, resulting in surface conforming to the tolerances specified.
2. Arrange forms to allow proper erection sequence and to permit form removal without damage to concrete.
3. Contractor to locate joints so as not to impair the strength of the structure. Location of joints to be acceptable to the Project Manager.
4. Provide openings in concrete for conduits etc. as required.

B. Slab Forms

1. Set edge forms and screeds to produce the indicated elevations and contours. Secure forms as required to prevent displacement during placement and consolidation of the concrete.
2. Set screeds in single course slabs, and at the top course of other slabs, as required for tops and finishes.
3. Slope forms to drain as indicated in the Contract Documents.

3.2 REMOVAL

- A. Remove forms by methods that will not damage the concrete. Do not pry against the concrete.

3.3 FIELD QUALITY CONTROL

- A. Before placing concrete, check lines and levels of erected formwork and positioning of embedded items, block-outs, and joints for correctness. Verify that embedded conduit, etc. are free from obstructions.
- B. While placing concrete, provide quality control to assure that formwork and related supports have not been displaced and that the completed work will be within specified tolerance.
- C. Placement of catenary pole anchor bolts and conduit is critical. Take necessary steps and ensure anchor bolts and conduit are placed properly as indicated in the Contract Documents.

END OF SECTION 031000

SECTION 032000

CONCRETE REINFORCEMENT

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 DESCRIPTION OF WORK

- A. This Section covers requirements for finishing and placing reinforcements for concrete structures.

1.4 RELATED SECTIONS

- A. Section 013000 - Submittals
- B. Section 014000 - Quality Control
- C. Section 033000 - Cast-in-Place-Concrete

1.5 QUALITY CONTROL

- A. Refer to Section 014000, Quality Control, for general requirements.
 - 1. Fabricate bars to meet the tolerances for:
 - a. Sheared length, depth of truss bars, overall dimensions of stirrup, ties and spirals and all other bends.
 - 2. Placement: Place bars as per contract plan.
 - 3. Submit details of tolerance limits to be followed.
 - 4. Interference: Bars may be moved as necessary to avoid interference with other reinforcing steel, conduits or embedded items. If bars are moved more than one bar diameter, or in excess of the above tolerances, the resulting arrangement of bars to be subject to acceptance by the Project Manager. Minimum spacing not to be decreased, and required number of bars to be placed.
 - 5. Site Work. Perform Site Quality Control as follows:
 - a. Perform Work in accordance with CRSI 63, CRSI 65, CRSI Manual of Practice, ACI 301, ACI SP66, AND ACI 318.
 - b. Maintain one copy of each document on site.
 - c. Submit copies of test report of reinforcement materials.

1.6 SUBMITTALS

- A. Refer to Section 013000, Submittals.

- B. Shop Drawings and Data: Provide reinforced steel details in conformance with ACI SP66, including marking, material size, cutting and bending dimensions, placement plans and details.
- C. Certificates. Submit a certified copy of test of materials.

1.7 STANDARDS

- A. Work of this Section to conform to the Concrete Reinforcing Steel Institute's Recommended Practice for Placing Reinforcing Bars".
- B. American Concrete Institute (ACI)
 - 301 Specifications for Structural Concrete for Buildings, Chapter 5, Reinforcement
 - SP66 Detailing Manual
 - 315 Manual of Standard Practice for Detailing Reinforced Concrete Structures
 - 318 Building Code and Commentary
- C. American Society of Testing and Materials (ASTM)
 - A82 Specification for Steel Wire, Plain, for Concrete Reinforcement
 - A184 Specifications for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
 - A185 Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
 - A370 Test Methods and Definitions for Mechanical Testing of Steel Products
 - A496 Specification for Steel Wire, Deformed, for Concrete Reinforcement
 - A497 Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
 - A615 Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
 - E8 Test Methods of Tension Testing of Metallic Materials
- D. Concrete Reinforcing Steel Institute (CRSI)
 - 1. Manual of Standards Practice
 - 2. CRSI Publication, "Reinforcement Anchorage and Splices"
 - 3. CRSI Publication, "Placing Reinforcing Bars"

1.8 PRODUCT DELIVERY, HANDLING AND STORAGE

- A. After fabrication, bundle and tag reinforcing steel for identification at job site. Provide tags identifying the steel by reinforcement item marking shown on accepted shop drawings and giving quantity of such items contained in bundle.

- B. Deliver steel reinforcement to job site, store and cover in a manner which will ensure that no damage occurs to it from moisture, dirt, grease, oil, or other cause which might impair bond with concrete.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Reinforcing steel bars to be deformed type conforming to ASTM A615, grade 60 unless otherwise indicated in the Contract Documents.
- B. Spiral Reinforcement and Reinforcing Wire:
 - 1. Plain: ASTM A82
 - 2. Deformed: ASTM A496
 - 3. Use plain except where deformed is indicated in the Contract Documents
- C. Welded Steel Wire Fabric:
 - 1. Plain: ASTM A185 (minimum requirement 70,000 psi yield point)
 - 2. Deformed: ASTM A497
 - 3. Use plain except where deformed is indicated in the Contract Documents
- D. Tie Wire to be mild steel or annealed iron, minimum 16 gauge.
- E. Provide supports such as chairs, bolsters, spacers, block hangers or other devices to support and position reinforcement of required strength and accepted design to prevent displacement of reinforcement.

2.2 FABRICATION

- A. General: After shop drawings have been accepted, fabricate each unit of reinforcement to conform to the type, shape and size as indicated in the Contract Documents.
- B. Cutting and Bending: Perform cutting and bending of reinforcing bars before shipment to the site. Bend bars cold in a manner that will not injure the material.

PART 3 - EXECUTION

3.1 PLACING OF REINFORCING STEEL

- A. Reinforcing steel to be clean and free of dirt, scale, paint, oil, grease and other foreign matter when placed in Work.
- B. Arrange and place reinforcement as shown on approved shop drawings.
- C. Support and secure reinforcement together as required in accordance with following requirements:
 - 1. Prevent displacement by construction loads or by the placing of concrete, beyond the tolerance.
 - 2. Tie or clip bars together securely.

3. Maximum spacing of bar supports to be four feet.

- D. Do not bend bars around openings or sleeves. Wherever piping, conduits, inserts, sleeves or other such items interfere with placing of reinforcement, obtain the Project Manager acceptance of placement before placing concrete.

3.2 BAR SUPPORTS AND SPACERS

- A. Support reinforcing bars in position by means of accepted spacers, chairs or hangers.
- B. Support reinforcing steel located in the bottom of slabs resting on earth on pre-cast concrete mortar blocks of the proper size and dimensions to position the steel.
- C. Maintain the specified tolerance between reinforcement and the forms by means of stays, blocks, ties, hangers or other accepted supports.

3.3 SPLICING AND LAPPING

- A. Furnish reinforcing bars in full length to the extent practicable. Splices and laps will be permitted only where shown on the accepted shop drawings or as otherwise permitted by the Project Manager.

END OF SECTION 032000

SECTION 033000

CONCRETE

PART 1 - GENERAL

RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

SUMMARY

- A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, form liners and finishes, for the following:
 - 1. Foundations
 - 2. Equipment pads.
 - 3. Light pole foundations.
 - 4. Driveways.
 - 5. Sidewalks.
 - 6. Curbs.

RELATED SECTIONS

- B. Section 013000 - Submittals
- C. Section 014000 - Quality Control
- D. Section 333100 – Sanitary Sewerage Utility Piping
- E. Section 334100 – Storm Utility and Structures

1.2 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO M 85, Standard Specification for Portland Cement.
 - 2. AASHTO M 148, Standard Specification for Liquid Membrane- Firming Compounds for Curing Concrete.
 - 3. AASHTO M 182, Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats.

4. AASHTO M 213, Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
- B. American Society for Testing and Materials International (ASTM):
1. ASTM C33, Standard Specification for Concrete Aggregates.
 2. ASTM C94, Standard Specification for Ready-Mixed Concrete.
 3. ASTM C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 4. ASTM C150, Standard Specification for Portland Cement.
 5. ASTM 0 1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 6. ASTM E329, Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
- C. Pennsylvania Department of Transportation Specifications, latest edition, Publication 408.

DEFINITIONS

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

1.3 SUBMITTALS

- A. Samples: Subbase aggregate.
- B. Submit mix design, equipment details, and vendor name for filed batched concrete.
- C. Submit copies of catalogue cuts of all fabricated materials for approval by the Client Agency prior to ordering.
- D. Submit all required testing reports including compressive strength testing.
- E. Submit Joint Layout Requirements as part of concrete pavement shop drawings showing expansion and control joints, layout information, etc. Submit concrete shop drawings showing elevation of all walls, expansion and control joints, form types, form layouts, form joints, ties, tie patterns, top of wall/finish, spot grades, etc.
- F. Qualification Data: For qualified ready-mix concrete manufacturer and testing agency.
- G. Material Certificates: For the following, from manufacturer:
 1. Cementitious materials.
 2. Concrete

3. Steel reinforcement and reinforcement accessories.
 4. Admixtures
 5. Air-entraining admixtures.
 6. Concrete curing compounds.
 7. Concrete curing and protecting covers
 8. Bonding agent or epoxy adhesive.
 9. Expansion joint fillers.
 10. Stone aggregate
- H. Material Test Reports: For aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
- I. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Experienced Workers: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and methods needed for proper performance of the work of this Section.
1. Materials and fabrication procedures are subject to inspection and testing at the source and the field by the independent quality assurance testing and inspection agency.
 2. Inspections and tests performed by the quality assurance testing and inspection agency do not relieve the Contractor of responsibility for providing materials and fabrication procedures in compliance with specified requirements listed in Section 01410.
- B. The independent quality assurance testing and inspection agency must conform to the quality standards of the nationally recognized associations and agencies that promulgate the test standards, particularly ASTM E329.
- C. Codes and Standards: Perform work in compliance with applicable requirements of governing authorities having jurisdiction.
- D. Materials and workmanship shall conform to applicable requirements of Pennsylvania Department of Transportation Specifications.
- E. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist")

2. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated. 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.
 3. 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.
- F. Concrete Testing Service: Contractor to engage an independent qualified testing agency to perform material evaluation tests and to design concrete mixtures.
- G. ACI Publications: Comply with ACI 301 (ACI 301M) unless otherwise indicated.
- H. 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 Professional and not less than 96 inches (2400 mm) by 96 inches (2400 mm).
 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Professional specifically approves such deviations in writing.
 4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. For delivery, storage and handling of concrete for pads and structures, conform to all requirements of PennDOT Publication 408 Section 501, Reinforced or Plain Cement Concrete Pavements.
- B. For general concrete, conform to all requirements of PennDOT Publication 408 Section 704, Cement Concrete.

1.6 PROJECT CONDITIONS

- A. Conform to all conditions and restrictions included in other sections, including erosion and sediment control, protection of vegetation, existing improvements and utilities.
 1. All work shall be in accordance with the laws of the State of Pennsylvania.
 2. All work shall be in accordance with the requirements of PennDOT Publication 408, latest edition.
 3. The Contractor shall apply and pay for all necessary permits and fees required in the course of his work as required by the governing codes.

4. The Contractor shall be responsible for coordinating his work with the work of other trades. Do no work that will damage, displace, or make unnecessarily difficult the installation of the work of other trades.
5. The Contractor shall not cover any work until it has been inspected by the Professional. Any work covered prior to inspection shall be opened to view by the Contractor at his expense.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS AND SUPPLIERS

A. Expansion Joint Material:

1. Williams Products, www.williamsproducts.net.
2. Tamms Industries, Kirkland, IL; (800) 862-2667; www.tams.com.
3. WR Meadows or equal as approved by the Professional.

B. Micro-reinforcement:

1. Nycon, Inc., www.nycon.com.
2. The Euclid Chemical Company, www.euclidchemical.com.
3. Sika
4. Propex

C. Integral Color Admixture: Integral Color Admixture: L.M. Scofield; (800) 800-9900; www.scofield.com.

D. Etching Solution: Klean Strip Green Muriatic Acid (Used for Control Mock-up) or other etching solution that will achieve an approved etched finish.

E. Dowel and Sleeve Products:

1. PNA Construction Technologies, Inc., www.pna-inc.com.
2. Sika Corporation, usa.sika.com.
3. Connelley

2.2 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. Erect forms true to line and grade. Maintain alignment using steel stakes at intervals not

greater than 4 feet

2. Use flexible or uniformly curved forms for curves with a radius of 100 feet (30.5 m) or less. Do not use notched and bent forms.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 CONCRETE MATERIALS

- A. Provide either Class AAA, AA, B or A concrete as described below and in PennDOT Publication 408, Section 704, Cement Concrete.
- B. For Class AAA and AA concrete use ready-mixed concrete; conform to ASTM C 94, latest edition; deliver and place within one hour after all materials have been placed in the mixing drum.
- C. For Class B and A concrete use ready-mixed or field mixed concrete.
- D. Proportion components, except water, by weight. Water may be measured by volume. One sack of Portland Cement consists of one cubic foot or 94 pounds. Proportion components to meet current version of PennDOT Publication 408 requirements, Section 704.1 Table A Cement Concrete Criteria. including:
 1. Class AAA Concrete:
 - a. Minimum sacks of cement per cubic yard: 6.75
 - b. Maximum water cement ratio: 0.43 lbs/lbs
 - c. Slump range: 1 – 3 inches
 - d. Minimum 28 day compressive strength: 4000 PSI
 2. Class AA Concrete:
 - a. Minimum sacks of cement per cubic yard: 6.25
 - b. Maximum water cement ratio: 0.477 lbs/lbs
 - c. Slump range: 1 - 3 inches
 - d. Minimum 28 day compressive strength: 3500 PSI
 3. Class A Concrete:
 - a. Minimum sacks of cement per cubic yard: 6
 - b. Maximum water cement ratio: 0.507 lbs/lbs
 - c. Slump range: 1 - 3 inches

- d. Minimum 28 day compressive strength: 3000 PSI
 - 4. Class B Concrete:
 - a. Minimum sacks of cement per cubic yard: 5
 - b. Slump range: 2 - 4 inches
 - c. Minimum 28 day compressive strength: 3000 PSI
- E. Cement: conform to the requirements of PennDOT Publication 408, Section 701, Cement.
- F. Cementitious Material: Conform to the requirements of PennDOT Publication 408, Section 701, Cement. Use the following cementitious materials, of same type, brand, and source throughout Project:
 - 1. Portland Cement: ASTM C 150 (AASHTO M 85), white portland cement Type II; color as required to produce concrete color approved by Professional. Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class C or Class F.
 - b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- G. Normal-Weight Aggregates: ASTM C 33, 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 (19 mm) nominal. Clean, hard and durable crushed stone or washed gravel; reasonably well graded from course to fine; per AASHTO T 27.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement. Clean, hard, durable particles of natural sand free from injurious amounts of organic impurities; conform to the gradation requirements of AASHTO T 27. Do not use fine aggregate produced from limestone in concrete wearing surfaces.
- H. Water: potable water free from injurious amounts of acids, alkalis, oils, sewage, vegetable matter and dirt and complying with ASTM C 94/C 94M.
- I. Air Content: design cement concrete with an air content of 4% to 7% in the plastic state.
 - 1. Air entraining agent: use in all Class A concrete; conform to ASTM C 260 (AASHTO M 154); add to the mixing water in solution; proportion to provide four (4) to seven (7) percent air in the concrete. Testing for air entrainment shall be in accordance with PennDOT Standard Specifications for Road and Bridge Construction.
- J. 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 C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.4 REINFORCING STEEL

- A. Epoxy coated steel bars: deformed, conforming to AASHTO-M284 (ASTM-D3963).
- B. Steel wire: conform to ASTM A 82, Cold-Drawn Steel Wire for Concrete Reinforcement.
- C. Steel Welded Wire Fabric: conform to AASHTO-M55 (ASTM-A185); gauge and mesh per plans. WWF shall be epoxy coated and conform to AASHTO-M284 (ASTM D3963) except as follows:
 1. Film Thickness — 5-12 Mills on at least 90% of the recorded film thickness measurements after cure.
 2. Continuity of Coating — No greater than an average of 2 holidays per square foot of welded wire fabric including holidays present at wire intersections if these are not attributable to weld spurs.
- D. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) plain-steel bars. Cut bars true to length with ends square and free of burrs.
- E. 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:
 3. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
- D. Adhesion — Evaluated on a representative number of equivalent size reinforcement bars that have been processed through the cleaning and coating production line along with the welded wire fabric sheets.
 1. Coating color — Light color shades which will reveal rusted or undercoated areas of steel.
- E. Submit reinforcing steel bars shop drawings for approval.
- F. All steel reinforcement: free from rust, scale, mortar, dirt, or other objectionable coatings.

2.4 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry or cotton mats.
- B. Moisture-Retaining Cover: ASTM C 171, 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 C 309, Type 1, Class B, dissipating.

2.5 RELATED MATERIALS

- A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.
- B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- C. Epoxy Bonding Adhesive: ASTM C 881/C 881M, 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, for bonding hardened or freshly mixed concrete to hardened concrete.
- D. 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 (3 to 6 mm).

2.6 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), 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.
- B. Proportion mixtures to provide normal-weight concrete with the following properties:
 - 1. Compressive Strength (28 Days): 4000 psi (24.1 MPa).
 - 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.
 - 3. Slump Limit: 3 inches (75 mm).
 - 4. Aggregate size: 1 inch.

- 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: 6 percent for 5/8-inch (16-mm) nominal maximum aggregate size.
- D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing admixture; high-range, water-reducing admixture; high-range, water-reducing and retarding admixture; or 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. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of Portland cement, which would otherwise be used, by not less than 40 percent.
- G. Cementitious Materials: Conform to the requirements of PennDOT Publication 408, Section 701, Cement. Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of Portland cement, which would otherwise be used, by not less than 40 percent.

2.7 SIDEWALK SURFACES

- A. Platforms and sidewalk surfaces shall have a medium broom finish perpendicular to traffic flow.

2.8 SOURCE QUALITY CONTROL

- A. Submit Certificates of Compliance from the quality assurance testing and inspection agency certifying that the materials provided comply with the specified requirements.
- B. Have the quality assurance testing and inspection agency perform acceptance testing of the stone aggregate at the source.

PART 3 EXECUTION

3.1 EXAMINATION

- A. All work to be done in accordance with PennDOT publication 408.
- B. Verify that previously installed protection measures are in place.
- C. Verify that all surfaces abutting new concrete pavement are clean, true and free from chips, etc.
- D. Examine the areas and conditions under which work is to be performed and notify the Professional in writing of conditions detrimental to the proper and timely completion of the work.

- E. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Perform excavation per Division 31, Section "Earth Moving".
- B. Do not place crushed stone on soft, muddy, or frozen areas. Correct irregularities or soft areas before placing crushed stone.
- C. Remove loose material from compacted subbase surface immediately before placing concrete.
- D. Place and secure forms to correct location, dimension, and profile as shown on plans..
 - 1. Expansion joints shall be placed at 15' maximum spacing.
- E. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
- F. 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 (5 km/h).
 - 2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
 - 3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch (13 mm) according to requirements in Section 312000 "Earth Moving."
- G. Moisten base to minimize absorption of water from fresh concrete.

3.3 INSTALLATION, GENERAL

- A. Concrete Class:
 - 1. Use minimum Class AA Concrete for concrete pads and curbs.
 - 2. Use Class AA Concrete in all manholes and other site structures.
 - 3. Use Class B or A Concrete for sidewalks, bedding and encasement only.
- B. Comply with ACI recommendations when placing concrete.
- C. Mix and deliver concrete in accordance with ASTM C94.
- D. All installation shall be done in accordance with PennDOT Publication 408 requirements.
- E. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
- F. Place reinforcing steel accurately in accordance with details shown on the plans and properly secure in position.
 - G. Vibrate all structural concrete as it is placed using internal vibrators capable of transmitting vibration to the concrete at frequencies not less than 4,500 impulses per minute. Do not use form vibrators. Limit vibration to provide satisfactory consolidation without causing segregation. Do not insert vibrator more than six (6) inches into the lower courses previously vibrated. Use vibrators in a substantially vertical position; insert at uniformly spaced points no farther apart than the visible effectiveness of the vibrator.
 - H. Vibration is not required in manhole bases and pipe encasements; consolidate concrete in these places with a tamping rod so a dense void free mass is formed.
 - I. Allow concrete to cure for at least 48 hours before stripping forms. If concrete is in a structural member, do not remove forms until the concrete can safely withstand all superimposed loads.
 - J. On all exposed surfaces, including the inside surface of manholes, remove all fins and projections so the surface is smooth. Cut out and fill any honeycombed areas with grout. Extensive honeycombing is not allowable.

3.4 CONCRETE PAVEMENT AND SIDEWALKS

- A. Place expansion joint filler between new and existing work and as shown on drawings and secure to formwork during concrete placement.
 1. Provide joint filler abutting existing concrete, concrete curbs, catch basins, inlets, manholes, and any other fixed objects.
 2. Recess joint filler 1/4 inch from top of slab.
- B. Construct control and construction joints in locations indicated on the Drawings.
 1. Form control joints in fresh concrete by grooving top portion with cutting tool and finishing edges with a metal edger having a 1/4-inch radius.
 2. Control joints shall have a depth of at least 1/4 of the concrete thickness.
 3. Space control joints at the width of the sidewalk, 6' maximum.
 4. Place construction joints at the end of placements and at locations where placement operations are stopped for more than 1 hour except where placements stop at expansion joints.
 5. Place expansion joints at 15' maximum spacing.
 6. Construct joints using standard metal keyway section forms.
 7. The concrete around light standards, poles, fire hydrants, access frames, and covers to

underground utilities, manhole frames and covers, and similar structures shall be scored, by edging or grooving, in a block 8 inches wider than the maximum dimensions of the structure.

- C. Maintain records of concrete placement. Record date, location of pour, quantity, air temperature, and test samples taken.
- D. Provide concrete pavement with a light broom finish perpendicular to traffic flow.
- E. The edges and perimeter and expansion and control joint scoring of all slabs shall be edged with a metal edger having a 1/4-inch radius to produce a dense compact border outlining each slab.

3.5 CONCRETE PADS AND FOOTINGS

- A. Before placing subbase, check subgrade for grade and slope. All slopes or locations not clear on the drawings shall be confirmed prior to placing of subbase. Place gravel subbase to depths and widths shown on the drawings. Subbase shall be compacted to form a hard, even, unyielding surface. All irregularities in the surface which exceed 1/2" shall be loosened and material added or removed as needed.
 - 1. Provide contraction, expansion and construction joints as shown on the drawings or specified here. All joints and edges shall be tooled to form neat edges. Contraction joints shall be to a depth equal to at least 1/4 concrete thickness. Expansion joints shall be no more than 30' apart and shall extend the full depth of paving or curbing. Construction joints shall be no more than 10' apart. Each poured section of curb shall be separated when pouring by a 1/8 inch steel template equal to the full depth of the curb.
 - 2. All exposed concrete surfaces shall be steel troweled and medium broomed to form a non-slip surface and remove shine.
 - 3. All exposed edges shall have 3/4" chamfer.
 - 4. All irregularities shall be a maximum of 1/4 inch in 10 ft. and 1/16 inch in 12 inches.

3.6 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.7 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

- D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.8 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. 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 (15.25 m) unless otherwise indicated.
 - 2. Extend joint fillers full width and depth of joint.
 - 3. Terminate joint filler not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished surface if joint sealant is indicated.
 - 4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
 - 5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 - 6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- 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:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch (6-mm) radius. Repeat grooving of

contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.

- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch (6-mm) radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.9 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 (ACI 301M) 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 (ACI 301M) 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 darbies 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. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
 - 1. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.

2. Do not use frozen materials or materials containing ice or snow.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
- K. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and as follows when hot-weather conditions exist:
1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.10 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleed-water 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. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch (1.6 to 3 mm) deep with a stiff-bristled broom, perpendicular to line of traffic.

3.11 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 (1 kg/sq. m 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. When the average daily temperature is less than 40° F, maintain temperature of newly placed concrete between 50° to 70° F during the required curing period.
- E. When the average daily temperature is above 70° F, protect the newly placed concrete from high temperatures and drying winds by keeping the concrete surface continually wet and by providing wind breaks during the required curing period.

- F. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- G. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, 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 (300-mm) 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 (300 mm) 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 that have been subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.
- H. Provide 30 days curing period before applying Special Coating

3.12 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
 - 1. Elevation: 3/4 inch (19 mm).
 - 2. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
 - 3. Surface: Gap below 10-foot- (3-m-) long, unlevelled straightedge not to exceed 1/2 inch (13 mm).
 - 4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches (13 mm per 300 mm) of tie bar.
 - 5. Lateral Alignment and Spacing of Dowels: 1 inch (25 mm).
 - 6. Vertical Alignment of Dowels: 1/4 inch (6 mm).
 - 7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches (6 mm per 300 mm) of dowel.
 - 8. Joint Spacing: 3 inches (75 mm).
 - 9. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.

10. Joint Width: Plus 1/8 inch (3 mm), no minus.

3.13 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor to engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 - 1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. (76 cu. m) or 5000 sq. ft. (465 sq. m) 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 C 143/C 143M; 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 C 231, 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 C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when it is 80 deg F (27 deg C) and above, and one test for each composite sample.
 - 5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 - 6. Compressive-Strength Tests: ASTM C 39/C 39M; 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 (3.4 MPa).
- D. Test results shall be reported in writing to Professional, 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 Professional 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 Professional.
- G. Submit samples of the subbase aggregate obtained from the construction site to the quality assurance testing and inspection agency for verification testing.
- H. Concrete paving will be considered defective if it does not pass tests and inspections.
- I. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- J. Prepare test and inspection reports.

3.14 REPAIRS 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 Professional.
- B. Drill test cores, where directed by Professional, 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 sidewalks from damage until acceptance of the work.
 - 1. Exclude pedestrians from walks for at least 3 days after placement.
 - 2. Provide necessary watchmen to prevent vandalism to freshly poured concrete walks.
- D. 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.
- E. 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.

3.15 CLEANING

- A. Sweep the concrete walks.
- B. Wash the concrete walks so they are free of stains, graffiti, discoloration, dirt, and other foreign materials.
 - 1. Completely remove graffiti from graffiti-marked sidewalks.
- C. Satisfactorily dispose of unsuitable and surplus materials provided under this Contract.

END OF SECTION 033001

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 RELATED DOCUMENTS

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

1.3 DESCRIPTION OF WORK

- A. Section Includes: Unit masonry assemblies consisting of the following:
 - 1. Standard concrete masonry units (CMUs).
 - 2. Architectural concrete masonry units
- B. Products installed, but not furnished, under this Section include the following:
 - 1. Steel lintels for unit masonry, furnished under Division 05 Section "Metal Fabrications."

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Material Certificates: For each type of product indicated. Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards.
 - 1. For masonry units, include material test reports substantiating compliance with requirements.
- C. Samples for Verification: Submit the following:
 - 1. Four representative samples of the masonry units showing the range of color, texture, dimension and any scoring, similar treatment.
 - 2. Pigmented mortar. Make Samples using same sand and mortar ingredients to be used on Project. Label Samples to indicate types and amounts of pigments used.
 - 3. Weep holes/vents.
 - 4. Accessories embedded in masonry.

1.5 QUALITY ASSURANCE

- A. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and

inspecting agency, by equivalent concrete masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

- B. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects.

- 1. Mockups shall be as specified in section 044313.13 1.5 B.

1.6 PROJECT CONDITIONS

- A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
- B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design Product: Subject to compliance with requirements, ground face concrete masonry units, by one of the following manufacturers or equal as approved by the Professional.
 - 1. Fizzano Brothers, Crum Lynne, PA
 - 2. Nitterhouse Masonry Products, LLC; Chambersburg, PA.
 - 3. Beavertown Block Co., Inc.; Middleburg, PA.

2.2 CONCRETE MASONRY UNITS (CMUs)

- A. Shapes: Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
- B. Concrete Masonry Units: ASTM C 90.
 - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi (13.1 MPa).
 - 2. Weight Classification: Normal weight, unless otherwise indicated.
- C. Concrete Building Brick: ASTM C 55.
 - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2500 psi (17.3 MPa).
 - 2. Weight Classification: Normal weight.

2.3 ARCHITECTURAL CONCRETE MASONRY UNITS

- A. Shapes: Provide special shapes for corners, jambs, sashes, movement joints, headers, bonding, and other special conditions. All exposed faces (tops of window sills, exposed corners, etc.) shall be finished.
- B. Ground Face Concrete Masonry Units:

1. Type and Color: As selected by Professional.

C. Manufacturing Requirements:

1. Type: Normal Weight, Medium Weight and Light Weight as required by mix design/color choice.
2. Hollow and Solid Load-Bearing Units: ASTM C 90.
3. Normal Weight Aggregates: ASTM C 33.
4. Light Weight Aggregates: ASTM C 331.
5. Portland Cements: ASTM C 150.
6. Compressive Strength: ASTM C140, 3500 psi minimum on the net area

2.4 CONCRETE AND MASONRY LINTELS

- A. General: For exposed conditions, provide masonry lintels complying with requirements below. For concealed conditions, provide either concrete or masonry lintels, at Contractor's option, complying with requirements below.
- B. Concrete Lintels: Precast units made from concrete matching concrete masonry units in color, texture, and compressive strength and with reinforcing bars indicated or required to support loads indicated. Cure precast lintels by same method used for concrete masonry units.
- C. Masonry Lintels: Built-in-place masonry lintels made from bond beam concrete masonry units with reinforcing bars placed as indicated and filled with coarse grout. Temporarily support built-in-place lintels until cured.

2.5 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for coldweather construction.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Aggregate for Mortar: ASTM C 144.
- D. Aggregate for Grout: ASTM C 404.
- E. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Addiment Incorporated; Mortar Kick.
 - b. Euclid Chemical Company (The); Accelguard 80.
 - c. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Morset.
 - d. Sonneborn, Div. of ChemRex; Trimix-NCA.

F. Water: Potable.

2.6 REINFORCEMENT

- A. Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60 (Grade 420).

- B. Masonry Joint Reinforcement, General: ASTM A 951.
1. Material: Hot-dip galvanized, carbon steel.
 2. Wire Size for Side Rods: W1.7 or 0.148-inch (3.8-mm) diameter.
 3. Wire Size for Cross Rods: W1.7 or 0.148-inch (3.8-mm) diameter.
 4. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (407 mm) o.c.
 5. Provide in lengths of not less than 10 feet (3 m), with prefabricated corner and tee units.
 6. Multiple-Wythe Masonry: Hohmann & Barnard 165 Adjustable Truss Reinforcement or approved equal.

2.7 TIES AND ANCHORS

A. Materials:

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153/A 153M, Class B-2 coating.
2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, hot-dip galvanized after fabrication to comply with ASTM A 153/A 153M.
3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

- B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch (16-mm) cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches (50 mm) parallel to face of veneer.

- C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches (100 mm) wide.

1. Wire: Fabricate from 3/16-inch (4.8-mm) diameter, hot-dip galvanized steel wire.

- D. Partition Top anchors: 0.097-inch- (2.5-mm-) thick metal plate with 3/8-inch- (10-mm-) diameter metal rod 6 inches (150 mm) 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.

2.8 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 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

- C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

2.9 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Limit cementitious materials in mortar to portland cement and lime.

3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
- B. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated:
1. Type M: For masonry below grade or in contact with earth.
 2. Type S: For applications where another type is not indicated.
- C. Grout for Unit Masonry: Comply with ASTM C 476.
1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
 2. Provide grout with a slump of 8 to 11 inches (200 to 280 mm) as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Use full-size units without cutting if possible. If cutting is required, cut units with motor driven saws; provide clean, sharp, unchipped edges. Install cut units with cut surfaces and, where possible, cut edges concealed.
- B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
- C. Comply with construction tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:
1. 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 (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) 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 (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.

3.2 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 (100-mm) horizontal face dimensions at corners or jambs.
- C. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- D. Fill space between steel frames and masonry solidly with mortar, unless otherwise indicated.

- E. Fill cores in hollow concrete masonry units with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

3.3 MORTAR BEDDING AND JOINTING

- A. Lay hollow masonry units as follows:
 - 1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
 - 2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
 - 3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
 - 4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
- B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.
- D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint), unless otherwise indicated.

3.4 MASONRY JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).
- B. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.

3.5 CONTROL AND EXPANSION JOINTS

- A. Install control joints in accordance with NCMA TEK 10-2, Control Joints for Concrete Masonry Walls, NCMA TEK 10-3, Control Joints For Concrete Masonry Walls - Alternative Engineered Method, and NCMA TEK 10-4, Crack Control For Concrete Brick and other Concrete Masonry Veneers.
- B. 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.
- C. Form control joints in concrete masonry using one of the following methods:
 - 1. Fit bond-breaker strips into hollow contour in ends of concrete masonry units 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.
- D. General: Install control 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.
- E. Form control joints in concrete masonry using preformed control-joint gaskets designed to fit standard sash block.
- 3.6 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS
- A. Install Flashing in accordance with NCMA TEK 19-04, Flashing Strategies for Concrete Masonry Walls, and NCMA TEK 19-05, Flashing Details for Concrete Masonry Walls.
- B. 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.
- C. Install flashing as follows, unless otherwise indicated:
1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
 2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 8 inches, and 1-1/2 inches into the inner wythe. Form 1/4-inch hook in edge of flashing embedded in inner wythe.
 3. At masonry-veneer walls, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least 8 inches; with upper edge covered with elastomeric membrane, lapping at least 4 inches.
 4. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
 5. Install air barrier transition strips to seal embedded flashings in masonry to air barrier membrane in accordance with Section 072700 – AIR BARRIERS.
- D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.
- E. Install metal drip edge plate in accordance with architectural details and manufacturer's requirements.
- F. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
1. Use specified weep/vent products to form weep holes.
 2. Space weep holes 24 inches o.c., unless otherwise indicated.
- G. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in Part 2 "Miscellaneous Masonry Accessories" Article.

H. Install vents in head joints in exterior wythes at spacing indicated.

3.7 REINFORCED UNIT MASONRY INSTALLATION

- A. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.
- B. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
 2. Limit height of vertical grout pours to not more than 60 inches (1520 mm).

3.8 FIELD QUALITY CONTROL

- A. Inspectors: Engage qualified independent inspectors to perform inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform inspections.
1. Place grout only after inspectors have verified compliance of grout spaces and grades, sizes, and locations of reinforcement.

3.9 CLEANING

- A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
1. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 2. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 3. Protect adjacent stone and non-masonry 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 cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.10 EXCESS MATERIALS AND WASTE

- A. Disposal as Fill Material: Dispose of clean masonry waste, including mortar and excess or soil-contaminated sand, by crushing and mixing with fill material as fill is placed.
1. Crush masonry waste to less than 4 inches (100 mm) in greatest dimension.
 2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Division 2 Site Work.
 3. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.

END OF SECTION 042000

SECTION 044313.13

ANCHORED STONE MASONRY VENEER

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Stone masonry anchored to unit masonry backup with outboard insulation.
 - 2. Stone masonry anchored to wood framing and sheathing with outboard insulation.
 - 3. Stone bench tops.
- B. Products Installed but Not Furnished under This Section Include:
 - 1. Steel lintels in unit masonry.
 - 2. Steel shelf angles for supporting unit masonry.
- C. Related Requirements:
 - 1. Section 042000 "Unit Masonry" for concealed flashing.

1.3 ACTION SUBMITTALS

- A. Product Data: For each variety of stone, stone accessory, and manufactured product.
- B. Samples:
 - 1. For each stone type indicated.
 - 2. For each color of mortar required.

1.4 FIELD CONDITIONS

- A. Protection of Stone Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work.
- B. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. 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 (4 deg C) and above and will remain so until masonry has dried.
- C. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Mockups: Build mockups to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Build mockup of typical wall area.
 2. Build mockups for typical exterior wall assemblies in sizes approximately 48 inches (1200 mm) long by 48 inches (1200 mm) high by full thickness, including face, flashings, backup construction, and all accessories.
 - a. Include a sealant-filled joint at least 16 inches (400 mm) long in mockup.
 3. Protect accepted mockups from the elements with weather-resistant membrane.
 4. Approval of mockups is for color, texture, and blending of stone; relationship of mortar and sealant colors to stone colors; tooling of joints; and aesthetic qualities of workmanship.
 - a. Approval of mockups is also for other material and construction qualities the Client Agency specifically approves in writing.
 - b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless the Client Agency specifically approves such deviations in writing.

1.6 WARRANTY

- A. Warrant flexible flashing material for life of wall.
- B. The Contractor warrants the work of this Section to be in accordance with the Contract Documents and free from faults and defects in materials and workmanship for a period of 15 years. The manufacturer of adhesives, liquid air and water barrier, mortars, pointing mortars and other installation materials shall provide a written fifteen (15) year warranty, which covers materials and labor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Stone: Obtain stone, regardless of finish, from single quarry, whether specified in this Section or in another Section of the Specifications, with resources to provide materials of consistent quality in appearance and physical properties.

- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of uniform quality for each cementitious component from single manufacturer and each aggregate from single source or producer.

2.2 STONE MATERIALS

- A. Basis of Design Varieties and Source: Subject to compliance with requirements, provide the following products in the percentages and of the characteristics indicated, obtained from Delaware Quarries, Inc . New Hope, PA (215) 862-1670 or equal product as approved by the Professional:
 - 1. Buff / Tan with Grey Weathering: 60 percent
 - a. Finish: Split or Natural Face
 - 2. PA Antique: 25 percent
 - a. Color Range: Bluestone
 - b. Finish: Split Face or Natural Cleft
 - 3. Plum / Red with Weathered Grey: 15 percent
 - a. Finish: Split Face or Natural Cleft
- B. The stone is intended to relate to the historic existing stone elements on site. Match the Professional's samples for color, finish, and other stone characteristics relating to aesthetic effects, excluding stone sizes.
- C. Stone bench tops: Provide Pennsylvania bluestone, in thicknesses and sizes as indicated on drawings

2.3 MORTAR MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or Type II, except Type III may be used for cold-weather construction; natural color or white cement may be used as required to produce mortar color indicated.
 - 1. Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C114.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in stone masonry mortar.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Davis Colors; True Tone Mortar Colors.
 - b. Lanxess Corporation; Bayferrox Iron Oxide Pigments.
 - c. Solomon Colors; SGS Mortar Colors.
- D. Colored Portland Cement-Lime Mix: Packaged blend of portland cement, hydrated lime, and mortar pigments. Mix shall produce color indicated or, if not indicated, as selected from

manufacturer's standard colors. Pigments shall not exceed 10 percent of portland cement by weight.

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. Holcim (US) Inc.; Rainbow Mortamix Custom Color Cement/Lime.
- b. Lafarge North America; Eaglebond.
- c. Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.

E. Aggregate: ASTM C144 and as follows:

1. For pointing mortar, use aggregate graded with 100 percent passing No. 16 (1.18-mm) sieve.
2. White Aggregates: Natural white sand or ground white stone.
3. Colored Aggregates: Natural-colored sand or ground marble, granite, or other sound stone; of color necessary to produce required mortar color.

F. Water: Potable.

2.4 VENEER ANCHORS

A. Materials:

1. Stainless Steel Wire: ASTM A580/A580M, Type 304.
2. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.

B. Size: Sufficient to extend at least halfway, but not less than 1-1/2 inches (38 mm), through stone masonry and with at least a 5/8-inch (16-mm) cover on exterior face.

C. Wire Veneer Anchors: Wire ties formed from W1.7 or 0.148-inch- (3.8-mm-) diameter, stainless steel wire.

D. Anchor spacing: not more than 18 inches o.c. vertically and 32 inches o.c. horizontally, with not less than one anchor per 2.67sf of wall area. Install additional anchors within 12 inches of openings, sealant joints, and perimeter at intervals not exceeding 12 inches.

E. Corrugated-Metal Veneer Anchors: Not less than 0.030-inch- (0.76-mm-) thick by 7/8-inch- (22-mm-) wide stainless steel sheet with corrugations having a wavelength of 0.3 to 0.5 inch (7.6 to 13 mm) and an amplitude of 0.06 to 0.10 inch (1.5 to 2.5 mm).

F. Adjustable, Screw-Attached Veneer Anchors: Units consisting of a wire tie section and a metal anchor section that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dur-O-Wal, a Dayton Superior Company; D/A 213 or D/A 210 with D/A 700-708.
 - b. Heckmann Building Products Inc.; 315-D with 316 or Pos-I-Tie.
 - c. Hohmann & Barnard, Inc.; DW-10 DW-10HS or DW-10-X.
 - d. Wire-Bond; 1004, Type III or RJ-711.

2. Structural Performance Characteristics: Capable of withstanding a 100-lbf (445-N) load in both tension and compression without deforming or developing play in excess of 0.05 inch (1.3 mm).
3. Wire Ties: Triangular-, rectangular-, or T-shaped wire ties fabricated from 0.188-inch- (4.8-mm-) diameter, stainless-steel wire.

2.5 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing, where flashing is exposed or partly exposed and where indicated, complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:
 1. Stainless Steel: ASTM A240/A240M, Type 304, 0.016 inch (0.4 mm) thick.
 2. Fabricate continuous flashings in sections 96 inches (2400 mm) long minimum, but not exceeding 12 feet (3.7 m). Provide splice plates at joints of formed, smooth metal flashing.
 3. Fabricate metal drip edges from stainless steel. Extend at least 3 inches (76 mm) into wall and 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.
 4. Fabricate metal sealant stops from stainless steel. Extend at least 3 inches (76 mm) into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch (19 mm) and down into joint 1/4 inch (6 mm) to form a stop for retaining sealant backer rod.
 5. Fabricate metal expansion-joint strips from stainless steel to shapes indicated.
- B. Flexible Flashing: For flashing unexposed to the exterior, use one of the following unless otherwise indicated:
 1. Stainless Steel-Laminated Flashing: Polymer fabric bonded to one face of Type 403 stainless steel core with non-asphaltic adhesive.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) STS Coatings, Inc.; Gorilla Flash Stainless Fabric
 - 2) Illinois Products, Inc.; IPCO Stainless Steel Fabric Flashing
 - 3) TK Products, Inc.
 - 4) York Manufacturing, Inc.; Multi-Flash S.S.
 - 5) Or approved equal.
 - b. Stainless Steel: Type 403, ASTM A167.
 - c. Fabric: Polymer fabric; laminated to back face of stainless steel core.
 - d. Size: Manufacturer's standard width rolls.
- C. Solder and Sealants for Sheet Metal Flashings: As specified in Section 076200 "Sheet Metal Flashing and Trim."
- 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.
- E. Corners and End Dams: Premanufactured.

- F. Termination Bars: Stainless Steel.

2.6 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene, urethane or PVC.
- B. Weep/Vent Products: Use one of the following unless otherwise indicated:
 - 1. Wicking Material: Absorbent rope, made from cotton or UV-resistant synthetic fiber, 1/4 to 3/8 inch (6 to 10 mm) in diameter, in length required to produce 2-inch (50-mm) exposure on exterior and 18 inches (450 mm) in cavity behind stone masonry. Use only for weeps.
 - 2. Round Plastic Tubing: Medium-density polyethylene, 3/8-inch (10-mm) OD by thickness of stone masonry.
 - 3. Mesh Weep Holes/Vents: Free-draining mesh; made from polyethylene strands, full width of head joint and 2 inches (50 mm) high by thickness of stone masonry; in color selected from manufacturer's standard.
- C. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
 - 1. Provide one of the following configurations:
 - a. Strips, full depth of cavity and 10 inches (250 mm) wide, with dovetail-shaped notches 7 inches (175 mm) deep that prevent mesh from being clogged with mortar droppings.
 - b. Strips, not less than 3/4 inch (19 mm) thick and 10 inches (250 mm) wide, with dimpled surface designed to catch mortar droppings and prevent weep holes from being clogged with mortar.
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Advanced Building Products Inc.; Mortar Break.
 - b. CavClear/Archovations, Inc.; CavClear Masonry Mat.
 - c. Dur-O-Wal, a Dayton Superior Company; Polytite MortarStop.
 - d. Mortar Net USA, Ltd.; Mortar Net.

2.7 FABRICATION

- A. Select stone to produce pieces of thickness, size, and shape indicated, including details on Drawings. Dress joints (bed and vertical) straight and at right angle to face unless otherwise indicated.
- B. Cut and drill sinkages and holes in stone for anchors and supports.
- C. Carefully inspect stone at quarry or fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units before shipment.

1. Clean sawed backs of stone to remove rust stains and iron particles.
- D. Thickness of Stone: Provide thickness indicated, but not less than the following:
1. Thickness: 4 inches (100 mm) plus or minus 1/4 inch (6 mm). Thickness does not include projection of pitched faces.
- E. Finish exposed stone faces and edges to comply with requirements indicated for finish and to match approved samples and mockup.

2.8 MORTAR MIXES

- A. General: Do not use admixtures unless otherwise indicated.
1. Do not use calcium chloride.
 2. Limit cementitious materials in mortar to portland cement and lime.
 3. Mixing Pointing Mortar: Thoroughly mix cementitious and aggregate materials together before adding water. Then mix again, adding only enough water to produce a damp, unworkable mix that will retain its form when pressed into a ball. Maintain mortar in this dampened condition for one to two hours. Add remaining water in small portions until mortar reaches required consistency. Use mortar within 30 minutes of final mixing; do not retemper or use partially hardened material.
- B. Mortar for Stone Masonry: Comply with ASTM C270, Proportion Specification.
1. Mortar for Setting Stone: Type N unless otherwise indicated, Type S for below-grade applications.
 2. Mortar for Pointing Stone: Type N unless otherwise indicated, Type S for below-grade applications.
- C. 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. Mix to match approved sample.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Accurately mark stud centerlines on face of weather-resistant sheathing paper before beginning stone installation.

3.2 INSTALLATION OF STONE MASONRY

- A. Perform necessary field cutting and trimming as stone is set.

1. Use power saws to cut stone that is fabricated with saw-cut surfaces. Cut lines straight and true, with edges eased slightly to prevent snipping.
 2. Use hammer and chisel to split stone that is fabricated with split surfaces. Make edges straight and true, matching similar surfaces that were shop or quarry fabricated.
 3. Pitch face at field-split edges as needed to match stones that are not field split.
- B. Sort stone before it is placed in wall to remove stone that does not comply with requirements relating to aesthetic effects, physical properties, or fabrication, or that is otherwise unsuitable for intended use.
- C. Arrange stones in pattern with course heights as indicated by manufacturer from approved shop drawings and submittals
- D. Arrange stones with color and size variations uniformly dispersed for an evenly blended appearance.
- E. Maintain uniform joint widths except for variations due to different stone sizes and where minor variations are required to maintain bond alignment if any. Lay walls with joints not less than 3/8 inch (10 mm) at narrowest points or more than 5/8 inch (16 mm) at widest points.
- F. Provide sealant joints of widths and at locations indicated.
1. Keep sealant joints free of mortar and other rigid materials.
 2. Sealant joints are specified in Section 079200 "Joint Sealants."
- G. Install embedded flashing and weep holes at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
1. At stud-framed walls, extend flashing through stone masonry, up sheathing face at least 8 inches (200 mm) and behind weather barrier.
 2. At multiwythe masonry walls, including cavity walls, extend flashing through stone masonry, turned up a minimum of 4 inches (100 mm), and extend into or through inner wythe to comply with requirements in Division 04 Section "Unit Masonry."
 3. At lintels and shelf angles, extend flashing full length of angles but not less than 6 inches (150 mm) into masonry at each end.
 4. At sills, extend flashing not less than 4 inches (100 mm) at ends.
 5. At ends of head and sill flashing, turn up not less than 2 inches (50 mm) to form end dams.
 6. Extend sheet metal flashing 1/2 inch (13 mm) beyond masonry face at exterior, and turn flashing down to form a drip.
 7. Install metal drip edges beneath flexible flashing at exterior wall face. Stop flexible flashing 1/2 inch (13 mm) back from exterior wall face and adhere flexible flashing to top of metal drip edge.
- H. Place weep holes and vents in joints where moisture may accumulate, including at base of cavity walls, above shelf angles, and at flashing.
1. Use wicking material, round plastic tubing, mesh weep holes/vents, or open head joints to form weep holes.
 2. Use wicking material to form weep holes above flashing in stone sills. Turn wicking down at lip of sill to be as inconspicuous as possible.

3. Space weep holes 16 inches (400 mm).
4. Trim wicking material used in weep holes flush with exterior wall face after mortar has set.
5. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

3.3 CONSTRUCTION TOLERANCES

- A. Variation from Plumb: For vertical lines and surfaces, do not exceed 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (10 mm in 6 m), or 1/2 inch in 40 feet (13 mm in 12 m) or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 1/4 inch in 20 feet (6 mm in 6 m) or 1/2 inch in 40 feet (13 mm in 12 m) or more.
- B. Variation from Level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed 1/4 inch in 20 feet (6 mm in 6 m) or 1/2 inch in 40 feet (13 mm in 12 m) or more.
- C. Variation of Linear Building Line: For position shown in plan, do not exceed 1/2 inch in 20 feet (13 mm in 6 m) or 3/4 inch in 40 feet (19 mm in 12 m) or more.

3.4 INSTALLATION OF ANCHORED STONE MASONRY

- A. Anchor stone masonry to unit masonry with corrugated-metal or individual **wire** veneer anchors unless otherwise indicated. Embed anchors in unit masonry mortar joints or grouted cells at a distance of at least one-half of unit masonry thickness.
- B. Anchor stone masonry to unit masonry with wire anchors unless otherwise indicated. Connect anchors to masonry joint reinforcement by inserting pintles into eyes of masonry joint reinforcement projecting from unit masonry.
- C. Anchor stone masonry to unit masonry with wire anchors unless otherwise indicated. Connect anchors to masonry joint reinforcement with vertical rods inserted through anchors and through eyes of masonry joint reinforcement projecting from unit masonry.
- D. Anchor stone masonry to stud framing with adjustable, screw-attached veneer anchors unless otherwise indicated. Fasten anchors through sheathing to framing with two screws.
- E. Embed veneer anchors in mortar joints of stone masonry at least halfway, but not less than 1-1/2 inches (38 mm), through stone masonry and with at least a 5/8-inch (16-mm) cover on exterior face.
- F. Space anchors not more than 18 inches (450 mm) o.c. vertically and 32 inches (800 mm) o.c. horizontally, with not less than one anchor per 2.67 sq. ft. (0.25 sq. m) of wall area. Install additional anchors within 12 inches (300 mm) of openings, sealant joints, and perimeter at intervals not exceeding 12 inches (300 mm).
- G. Set stone in full bed of mortar with full head joints unless otherwise indicated. Build anchors into mortar joints as stone is set.

- H. Fully bond intersections and external corners.
- I. Provide cavity between stone masonry and backup construction unless otherwise indicated. Keep cavity free of mortar droppings and debris.
 - 1. Slope beds toward cavity to minimize mortar protrusions into cavity.
 - 2. Do not attempt to trowel or remove mortar fins protruding into cavity.
- J. Rake out joints for pointing with mortar to depth of not less than 3/4 inch (19 mm) before setting mortar has hardened. Rake joints to uniform depths with square bottoms and clean sides.

3.5 POINTING

- A. Prepare stone-joint surfaces for pointing with mortar by removing dust and mortar particles. Where setting mortar was removed to depths greater than surrounding areas, apply pointing mortar in layers not more than 3/8 inch (10 mm) deep until a uniform depth is formed.
- B. Point stone joints by placing and compacting pointing mortar in layers of not more than 3/8 inch (10 mm) deep. Compact each layer thoroughly and allow to it become thumbprint hard before applying next layer.
- C. Tool joints, when pointing mortar is thumbprint hard, with a smooth jointing tool to produce the following joint profile:
 - 1. Joint Profile: Smooth, flat face slightly below edges of stone.

3.6 ADJUSTING AND CLEANING

- A. In-Progress Cleaning: Clean stone masonry as work progresses. Remove mortar fins and smears before tooling joints.
- B. Final Cleaning: After mortar is thoroughly set and cured, clean stone masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Test cleaning methods on mockup; leave one-half of panel uncleaned for comparison purposes. Obtain Professional's approval of sample cleaning before cleaning stone masonry.
 - 3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
 - 4. Wet wall surfaces with water before applying cleaner; remove cleaner promptly by rinsing thoroughly with clear water.
 - 5. Clean stone masonry by bucket and brush hand-cleaning method described in BIA Technical Note No. 20, Revised II, using job-mixed detergent solution.
 - 6. Clean stone masonry with proprietary acidic cleaner applied according to manufacturer's written instructions.
 - 7. Clean limestone masonry to comply with recommendations in ILI's "Indiana Limestone Handbook."

3.7 EXCESS MATERIALS AND WASTE

- A. Excess Stone: Stack excess stone where directed by Client Agency for Client Agency's use.
- B. Disposal as Fill Material: Dispose of clean masonry waste, including mortar and excess or soil-contaminated sand, by crushing and mixing with fill material as fill is placed.
 - 1. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.

END OF SECTION 044313.13

SECTION 051200

STRUCTURAL STEEL

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 DESCRIPTION OF WORK

- A. The work specified in this section consists of furnishing, fabricating, galvanizing, erecting and grouting structural steel in accordance with the extent of work and the details indicated on Contract Drawings, as specified herein and as required for complete installation and modification. Structural Steel, as referenced herein is that work defined in the "AISC" code of standard practice for steel buildings and bridges and as otherwise shown on Contract Drawings.
- B. Modifications to existing structures, as shown on the Contract Drawings.
- C. The following work items are included in other divisions of these specifications:
 - 1. Installation of anchor bolts and other embedded metal items
 - 2. Excavation and backfill, and selective demolition.

1.4 RELATED WORK

- A. All Sections in Division 03 - Concrete
- B. Section: 055000 - Metal Fabrication

1.5 APPLICABLE STANDARDS AND CODES

- A. All workmanship and material shall conform to the following standards except as otherwise directed herein or on the drawings:
 - 1. American Institute of Steel Construction (AISC), "Specification for Structural Steel Buildings" 1989 Edition, with latest revisions.
 - 2. AISC, "Code of Standard Practice for Steel Buildings and Bridges" 1986 Edition.
 - 3. American Railway Association, (AREA) Manual for Railway Engineering, Chapter 15, Steel Structures.
 - 4. Research Council on Riveted and Bolted Structural Joints (RCRBSJ), "Specification for Structural Joints Using ASTM A325 or A490 Bolts."
 - 5. American Society for Testing and Materials (ASTM), "Structural Steel" A36.
 - 6. American Society for Testing and Materials (ASTM), "Structural Steel" A588.

7. American Society for Testing and Materials (ASTM), "Structural Steel" A992.
8. ASTM, "Standard Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed and Forged Steel Shapes, Plates, Bars, and Strip" A123.
9. ASTM, "Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware" A153.
10. ASTM, Specification "Standard Specification for High-Strength Bolts for Structural Steel Joints, Including Nuts and Washers" A325.
11. ASTM, "Specification for Concentric-Lay-Stranded Aluminum-Clad Steel Conductor" B-416.
12. ASTM, "Steel Castings, High Strength, for Structural Purposes" A148.
13. ASTM, "Steel Forgings, Carbon and Alloy for General Industrial Use" A668.
14. American Welding Society (AWS), "Structural Welding Code" D1.1.
15. Steel Structures Painting Council (SSPC), "Commercial Blast Cleaning" SP-6.

1.6 QUALITY ASSURANCE

- A. Comply with provisions of current AISC, relevant AWS, and other applicable standards.

1.7 SUBMITTALS

- A. The Contractor shall submit drawings, reports and samples of the work covered by this contract in strict compliance with the provisions of these specifications.
- B. The Contractor shall submit fabrication and erection (shop) drawings for review by the Project Manager.
 1. Shop drawings shall give complete information necessary for the fabrication of the members and components of the structures including: material specifications and the location, type and sizes of all bolts and welds.
 2. The drawings shall clearly distinguish between all shop and field bolts and welds.
 3. All shipping assemblies shall be noted and given mark numbers on the erection drawings.
 4. The contractor shall complete the design of connections for the loads shown on the drawings, or where such loads are not indicated, a minimum load equivalent to the capacity of two (2) 3/4" A-325 bolts.
 - a. All bolt design shall be bearing type with threads included in the plane of shear (Type N).
 5. Review for shop drawings by the Project Manger shall not relieve the Contractor of the responsibility for errors in fabrication. The Contractor shall be responsible for connection design, dimensions, details, and for the correct fit of structural members.
- C. Submit certified copies of mill test reports for review by the Project Manager in accordance with the Special provisions.

PART 2 - PRODUCTS AND MATERIALS

2.1 STRUCTURAL STEEL

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.
- B. W-Shapes: ASTM A 992/A 992M.

- C. Channels, Angles, M, S-Shapes: ASTM A 36/A 36M.
- D. Plate and Bar: ASTM A 36/A 36M.
- E. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.
- F. HSS sections: ASTM A1085
- G. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
 - 1. Weight Class: Standard, unless otherwise indicated in Contract Documents.
 - 2. Finish: As noted on drawings.
- H. Steel Castings: ASTM A 216/A 216M, Grade WCB with supplementary requirement S11.
- I. Steel Forgings: ASTM A 668/A 668M.

2.2 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.
 - 1. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with plain finish.
- B. High-Strength Bolts, Nuts, and Washers: ASTM A 490, Type 1, heavy-hex steel structural bolts or tension-control, bolt-nut-washer assemblies with splined ends; ASTM A 563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers with plain finish.
 - 1. Direct-Tension Indicators: ASTM F 959, Type 490, compressible-washer type with plain finish.
- C. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers.
 - 1. Finish: Hot-dip or mechanically deposited zinc coating.
 - 2. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with mechanically deposited zinc coating finish.
- D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
 - 1. Finish: Plain or mechanically deposited zinc coating.
- E. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
- F. Unheaded Anchor Rods: ASTM F 1554, Grade 55, weldable.

1. Configuration: Straight or Hooked as indicated.
2. Nuts: ASTM A 563 (ASTM A 563M) heavy-hex carbon steel.
3. Plate Washers: ASTM A 36/A 36M carbon steel.
4. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
5. Finish: Plain, Hot-dip zinc coating, ASTM A 153/A 153M, Class C or Mechanically deposited zinc coating, ASTM B 695, Class 50.

G. Headed Anchor Rods: ASTM F 1554, Grade 55, weldable, straight.

1. Nuts: ASTM A 563 (ASTM A 563M) heavy-hex carbon steel.
2. Plate Washers: ASTM A 36/A 36M carbon steel.
3. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
4. Finish: Plain, Hot-dip zinc coating, ASTM A 153/A 153M, Class C or Mechanically deposited zinc coating, ASTM B 695, Class 50.

H. Threaded Rods: ASTM A572 Grade 50.

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

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

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

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

2.3 WELDING ELECTRODES

- A. Welding electrodes for shop fabrication shall conform to the requirements of the AWS Structural Welding Code D1.1, for Series E 70xx.
- B. Welding electrodes for field assembly shall conform to AWS type E 6010, and shall be compatible to galvanized steel.

2.4 TEMPORARY MATERIAL

- A. Provide all temporary bracing, shoring, supports and guys.
- B. Provide temporary fit up bolts and all tools and equipment required for erection of structural steel.

2.5 PRIMER

- A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Primer: Comply with Section 099600 "High Performance Coatings".

C. Galvanizing Repair Paint: ASTM A 780.

2.6 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, 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 according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.

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

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

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

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

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

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC- SP 1, "Solvent Cleaning" or SSPC-SP 2, "Hand Tool Cleaning."

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

G. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural steel. Straighten as required to provide uniform, square, and true members in completed wall framing.

H. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing 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 according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened unless indicated as slip critical in contract documents.
- B. Weld Connections: Comply with AWS D1.1/D1.1M 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 will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.9 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
 - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
 - 2. Surfaces to be field welded.
 - 3. Surfaces to be high-strength bolted with slip-critical connections.
 - 4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
 - 5. Galvanized surfaces.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
 - 1. SSPC-SP 6, "Commercial Blast Cleaning."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 - 2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

2.10 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.
 - 1. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.
 - 2. Galvanized finish will be the permanently exposed finish of the steel unless noted otherwise. Galvanized finish must be protected throughout the delivery and installation of the structural steel members, as well as throughout the duration of the construction process steel erection is complete.

2.11 SOURCE QUALITY CONTROL

- A. Testing Agency: The Contractor will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.
 - 1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.
- C. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- D. Welded Connections: In addition to visual inspection, shop-welded CJP connections will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - 1. Liquid Penetrant Inspection: ASTM E 165.
 - 2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld.
Cracks or zones of incomplete fusion or penetration will not be accepted.
 - 3. Ultrasonic Inspection: ASTM E 164.
 - 4. Radiographic Inspection: ASTM E 94.
- E. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
 - 1. Bend tests will be performed if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
 - 2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1/D1.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify, with 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 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.

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
- B. Base, Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
 - 1. Set plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Weld plate washers to top of baseplate.
 - 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 - 4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure.
 - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Do not use thermal cutting during erection.
- G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened, Pretensioned, or Slip critical, as indicated on drawings.
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: The Construction Manager will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.
- B. Bolted Connections: Bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- C. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.
 1. In addition to visual inspection, CJP field welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E 165.
 - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - c. Ultrasonic Inspection: ASTM E 164.
 - d. Radiographic Inspection: ASTM E 94.
- D. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
 1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
 2. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1/D1.1M.
- E. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.6 REPAIRS AND PROTECTION

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.
 1. Restore surfaces permanently exposed to view to meet conditions of factory galvanized finish.
- B. Touchup Painting: Immediately after erection, clean exposed areas of primed steel where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 1. Clean and prepare surfaces by SSPC-SP 3 power-tool cleaning.

- C. Touchup Painting: Cleaning and touchup painting are specified in Section 099600 "High Performance Coatings".

3.7 DELIVERY

- A. All structural steel assemblies shall be properly tagged with member markings in agreement with the approved erection drawings.
- B. Loose material, including bolts, nuts, washers, and clips shall be promptly tagged and packaged to prevent loss and to assure ready identification at the jobsite.
- C. The Contractor shall load and deliver fabricated assemblies to the site.
 - 1. Delivery locations and dates shall be coordinated.
 - 2. Structural steel shall be properly protected from damage, deterioration and loss during loading and transit to the delivery point.

3.8 RECEIVING AND STORING

- A. All material shall be stored on supports above ground and shall be protected from damage by traffic or other contractor operations.
- B. Material shall be received and stored for ease of identification and for retrieval in the order of installation.
 - 1. Coordinate with fabricator.
- C. Loose material including bolts, nuts and washers shall be received properly packaged and labeled and shall be stored to facilitate retrieval.

END OF SECTION 051200

SECTION 055000

METAL FABRICATIONS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Miscellaneous steel framing and supports.
- 2. Miscellaneous steel trim.
- 3. Metal downspout boots adapter.
- 4. Loose bearing and leveling plates.
- 5. Loose steel lintels.

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

- 1. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
- 2. Steel weld plates and angles for casting into concrete.

1.3 ACTION SUBMITTALS

- A. Product Data: For the following:

- 1. Fasteners.
- 2. Shop primers.
- 3. Shrinkage-resisting grout.
- 4. Metal downspout boots.

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

1.4 PROJECT CONDITIONS

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

1.5 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. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- C. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- D. Stainless Steel Bars and Shapes: ASTM A276/A276M, Type 304.
- E. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.
- F. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.
- G. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.
- H. Aluminum Extrusions: ASTM B221 (ASTM B221M), Alloy 6063-T6.

2.2 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
 - 1. Provide stainless steel fasteners for fastening aluminum or stainless steel.
- B. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.
- C. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless steel bolts, ASTM F593 (ASTM F738M), and nuts, ASTM F594 (ASTM F836M).
- D. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches (41 by 22 mm) by length indicated with anchor straps or studs not less than 3 inches (75 mm) long at not more than 8 inches (200 mm) o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B633, Class Fe/Zn 5, as needed for fastening to inserts.

2.3 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."
- B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
1. Use primer with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR, Subpart D (EPA Method 24).
- C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.
- D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- H. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- I. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa).

2.4 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c.

2.5 MISCELLANEOUS FRAMING AND SUPPORTS

- A. 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.
- B. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill or punch baseplates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness unless otherwise indicated.

2.6 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
- C. Galvanize exterior miscellaneous steel trim.
- D. Prime miscellaneous steel trim.

2.7 METAL DOWNSPOUT BOOT ADAPTER

- A. Provide downspout boot adapter made from stainless steel with inlets of size and shape to suit downspouts. Provide units with flanges and holes for countersunk anchor bolts.
- B. Manufacturers: Subject to compliance with requirements, provide Piedmont Pipe Construction, Inc. Model SO Offset Vertical Outlet and A1 Adapter, with debris evacuation system, or approved equal by one of the following:
 1. Neenah Foundry, Model R2946 with R4927 Adapter.
 2. J.R.Hoe, O-Series Offset Downspout Boot
- C. Downspout Adapter Body: Standard construction shall be 12 gauge 0.1094" thick Stainless Steel, ASTM A 240/A 240M, Type 304. Body size to be as indicated on the bid documents. Downspout bodies shall have factory-applied powdercoat finish, 2-5mil UV resistant polyurethane finish coating, in color as selected by the Professional from manufacturer's standard range.
 1. Adapter Body Height: 24 inches.
 2. Offset Dimension: 3-1/2 inches.
- D. Downspout Adapter Collar: Provide 12 gauge 0.1094" thick Stainless Steel, ASTM A 240/A 240M, Type 304, collar to accept the downspout shape and size as indicated in the drawings.
- E. Internal Sweep: Provide an electronically fused internal sweep elbow to ensure a smooth quiet transition of flow on all horizontal outlet boots. The internal sweep elbow shall be manufactured of 12 gauge 0.1094" thick Stainless Steel, ASTM A 240/A 240M, Type 304.
- F. Boot Discharge Outlets: Shall be ASTM A 240/A240M, Type 304 stainless steel and shall be sized for connection to the roof drain leader piping.
- G. Cleanout: Downspout boot shall be fitted with a self-cleaning debris trap. The self-evacuating debris trap door shall be 12 gauge 0.1094" thick Stainless Steel, ASTM A 240/A 240M, Type 304. The debris trap door shall be hinged and balanced to allow debris to be evacuated by the flow of water only. A removable stainless steel debris screen, ASTM A 240/A 240M, Type 304 shall be installed to protect the roof drain leader piping from debris.

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. Galvanize bearing and leveling plates.
- C. Prime plates with primer specified in Section 099600 "High-Performance Coatings."

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. Galvanize and prime loose steel lintels located in exterior walls.
- C. Prime loose steel lintels located in exterior walls with primer specified in Section 099113 "Painting."

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 GENERAL FINISH REQUIREMENTS

- 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. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
 - 1. Shop prime with universal shop primer unless zinc-rich primer is primers specified in Section 099600 "High-Performance Coatings" are indicated.
- C. Preparation for Shop Priming: Prepare surfaces to comply with minimum requirements indicated below:
 - 1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 4. Other Steel Items: SSPC-SP 3, "Power Tool Cleaning."

5. Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."
- D. 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 so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

- A. Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

3.3 INSTALLATION OF 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 shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 INSTALLATION OF DOWNSPOUT BOOT ADAPTERS

- A. General: Install downspout adapters according to manufacturer's written instructions. Anchor securely in place and capable of resisting forces specified. Install downspout adapters to resist exposure to weather without failing, rattling, leaking, and fastener disengagement.
- B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by fabricator or manufacturers of dissimilar metals.
- C. Seal anchor penetrations with elastomeric sealant as required by manufacturer of downspout adapters.

3.5 REPAIRS

- A. Touchup Painting:
 - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with 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 A780/A780M.

END OF SECTION 055000

SECTION 061000

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. Framing with dimension lumber.
 - 2. Framing with engineered wood products.
 - 3. Wood blocking, cants, and nailers.
 - 4. Wood furring and grounds.
 - 5. Wood sleepers.
 - 6. Utility shelving.
 - 7. Plywood backing panels.

1.3 DEFINITIONS

- A. Exposed Framing: Framing not concealed by other construction.
- B. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.
- C. Lumber grading agencies, and the abbreviations used to reference them, include the following:
 - 1. NeLMA: Northeastern Lumber Manufacturers' Association.
 - 2. NLGA: National Lumber Grades Authority.
 - 3. RIS: Redwood Inspection Service.
 - 4. SPIB: The Southern Pine Inspection Bureau.
 - 5. WCLIB: West Coast Lumber Inspection Bureau.
 - 6. WWPA: Western Wood Products Association.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 - 2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include

physical properties of treated materials based on testing by a qualified independent testing agency.

3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

B. Fastener Patterns: Full-size templates for fasteners in exposed framing.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.

B. Evaluation Reports: For the following, from ICC-ES:

1. Wood-preservative-treated wood.
2. Fire-retardant-treated wood.
3. Engineered wood products.

1.6 QUALITY ASSURANCE

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

1.7 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation.

Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Certified Wood: Materials 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 for the following:

1. Dimension lumber framing.
2. Laminated-veneer lumber.
3. Miscellaneous lumber.

- B. 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. For exposed lumber indicated to receive a stained or natural finish, omit grade stamp and provide certificates of grade compliance issued by grading agency.
 3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
 4. Provide dressed lumber, S4S, unless otherwise indicated.
- C. Maximum Moisture Content of Lumber: 15 percent for 2-inch nominal thickness or less, 19 percent for more than 2-inch nominal thickness unless otherwise indicated.
- D. Engineered Wood Products: Provide engineered wood products acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.
1. Allowable Design Stresses: Provide engineered wood products with allowable design stresses, as published by manufacturer that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

- 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.
1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.
 2. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that 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.
1. For exposed lumber indicated to receive a stained or natural finish, omit marking and provide certificates of treatment compliance issued by inspection agency.
- D. Application: Treat all rough carpentry unless otherwise indicated.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, 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 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. Use treatment that does not promote corrosion of metal fasteners.
 - 2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
 - 3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
 - 4. Design Value Adjustment Factors: Treated lumber shall be tested according ASTM D 5664 and design value adjustment factors shall be calculated according to ASTM D 6841. For enclosed roof framing, framing in attic spaces, and where high temperature fire-retardant treatment is indicated, provide material with adjustment factors of not less than 0.85 modulus of elasticity and 0.75 for extreme fiber in bending for Project's climatological zone.
- C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent.
- D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
 - 1. For exposed lumber indicated to receive a stained or natural finish, omit marking and provide certificates of treatment compliance issued by testing agency.
- E. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.
- F. Application: Treat all rough carpentry unless otherwise indicated.

2.4 DIMENSION LUMBER FRAMING

- A. Non-Load-Bearing Interior Partitions: Construction or No. 2 grade.
 - 1. Application: Interior partitions at the stables building.
- B. Joists, Rafters, and Other Framing Not Listed Above: Any species and grade with a modulus of elasticity of at least 1,400,000 psi and an extreme fiber stress in bending of at least 875 psi for 2-inch nominal thickness and 12-inch nominal width for single-member use.

- C. Exposed Framing: Provide material hand-selected for uniformity of appearance and freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot-holes, shake, splits, torn grain, and wane.
 - 1. Application: Exposed exterior and interior framing indicated to receive a stained or natural finish.
 - 2. Species and Grade: As indicated above for To match adjacent load-bearing construction that is exposed to view of same type.

2.5 ENGINEERED WOOD PRODUCTS

- A. Engineered Wood Products, General: Products shall contain no urea formaldehyde and must comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Source Limitations: Obtain each type of engineered wood product from single source from a single manufacturer.
- C. Laminated-Veneer Lumber: Structural composite lumber made from wood veneers with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D 5456 and manufactured with an exterior-type adhesive complying with ASTM D 2559.
 - 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 or equal as approved by the Professional.
 - a. Boise Cascade Corporation.
 - b. Finnforest USA.
 - c. Georgia-Pacific.
 - d. Jager Building Systems Inc.
 - e. Louisiana-Pacific Corporation.
 - f. Pacific Woodtech Corporation.
 - g. Roseburg Forest Products Co.
 - h. Standard Structures Inc.
 - i. Stark Truss Company, Inc.
 - j. West Fraser Timber Co., Ltd.
 - k. Weyerhaeuser Company.
 - 2. Extreme Fiber Stress in Bending, Edgewise: 2,600 psi for 12-inch nominal- depth members.
 - 3. Modulus of Elasticity, Edgewise: 2,000,000 psi.

2.6 MISCELLANEOUS LUMBER

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

6. Utility shelving.
- B. For items of dimension lumber size, provide Construction or No. 2 and any of the following species:
1. Hem-fir (north); NLGA.
 2. Mixed southern pine; SPIB.
 3. Spruce-pine-fir; NLGA.
 4. Hem-fir; WCLIB or WWPA.
 5. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
 6. Western woods; WCLIB or WWPA.
 7. Northern species; NLGA.
 8. Eastern softwoods; NeLMA.
- C. For utility shelving, provide lumber with 15 percent maximum moisture content and any of the following species and grades:
1. Eastern white pine, Idaho white, lodgepole, ponderosa, or sugar pine; Premium or No. 2 Common (Sterling) or Standard or No. 3 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
 2. Mixed southern pine; No. 1 or 2 grade; SPIB.
 3. Hem-fir or hem-fir (north); Select Merchantable or No. 1 Common or Construction or No. 2 Common grade; NLGA, WCLIB, or WWPA.
 4. Spruce-pine-fir (south) or spruce-pine-fir; Select Merchantable or No. 1 Common or Construction or No. 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
- D. For concealed boards, provide lumber with 15 percent maximum moisture content and any of the following species and grades:
1. Mixed southern pine; No. 2 or 3 grade; SPIB.
 2. Eastern softwoods; No. 2 or 3 Common grade; NeLMA.
 3. Northern species; No. 2 or 3 Common grade; NLGA.
 4. Western woods; Construction or No. 2 Common or Standard or No. 3 Common grade; WCLIB or WWPA.
- E. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- F. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
- G. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.
- 2.7 PLYWOOD BACKING PANELS
- A. Equipment Backing Panels: DOC PS 1, Exterior, AC, 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."

2.8 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Lag Bolts: ASME B18.2.1.
- F. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.
- G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.

2.9 METAL FRAMING ANCHORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following or equal as approved by the Professional:
 1. Cleveland Steel Specialty Co.
 2. KC Metals Products, Inc.
 3. Phoenix Metal Products, Inc.
 4. Simpson Strong-Tie Co., Inc.
 5. USP Structural Connectors.
- C. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer that meet or exceed those of basis-of-design products of products of manufacturers listed. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

- D. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 coating designation.
1. Use for interior locations unless otherwise indicated.
- E. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A 653/A 653M; structural steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 coating designation; and not less than 0.036 inch thick.
1. Use for wood-preserved-treated lumber and where indicated.
- F. Stainless-Steel Sheet: ASTM A 666, Type 304.
1. Use where indicated.
- G. Joist Hangers: U-shaped joist hangers with 2-inch- long seat and 1-1/4-inch- wide nailing flanges at least 85 percent of joist depth.
1. Thickness: 0.050 inch or 0.062 inch, as needed.
- H. I-Joist Hangers: U-shaped joist hangers with 2-inch long seat and 1-1/4-inch- wide nailing flanges full depth of joist. Nailing flanges provide lateral support at joist top chord.
1. Thickness: 0.050 inch or 0.062 inch, as needed.
- I. Top Flange Hangers: U-shaped joist hangers, full depth of joist, formed from metal strap with tabs bent to extend over and be fastened to supporting member.
1. Strap Width: 1-1/2 - 2 inches, as needed.
 2. Thickness: 0.050 inch or 0.062 inch, as needed.
- J. Bridging: Rigid, V-section, nailless type, 0.050 inch thick, length to suit joist size and spacing.
- K. Post Bases: Adjustable-socket type for bolting in place with standoff plate to raise post 1 inch above base and with 2-inch- minimum side cover, socket 0.062 inch thick, and standoff and adjustment plates 0.108 inch thick.
- L. Joist Ties: Flat straps, with holes for fasteners, for tying joists together over supports.
1. Width: 3/4 inch or 1-1/4 inches, as needed.
 2. Thickness: 0.050 inch or 0.062 inch, as needed.
 3. Length: As indicated.
- M. Rafter Tie-Downs: Bent strap tie for fastening rafters or roof trusses to wall studs below, 1-1/2 inches wide by 0.050 inch thick. Tie fastens to side of rafter or truss, face of top plates, and side of stud below.
- N. Floor-to-Floor Ties: Flat straps, with holes for fasteners, for tying upper floor wall studs to band joists and lower floor studs, 1-1/4 inches wide by 0.050 inch thick by 36 inches long.

- O. Hold-Downs: Brackets for bolting to wall studs and securing to foundation walls with anchor bolts or to other hold-downs with threaded rods and designed with first of two bolts placed seven bolt diameters from reinforced base.
 - 1. Bolt Diameter: 5/8 inch or 3/4 inch, as needed
 - 2. Width: 2-1/2 inches or 3-3/16 inches, as needed.
 - 3. Body Thickness: 0.108 inch or 0.138 inch, as needed.
 - 4. Base Reinforcement Thickness: 0.108 inch or 0.239 inch, as needed.
- P. Wall Bracing: T-shaped bracing made for letting into studs in saw kerf, 1-1/8 inches wide by 9/16 inch deep by 0.034 inch thick with hemmed edges.
- Q. Wall Bracing: Angle bracing made for letting into studs in saw kerf, 15/16 by 15/16 by 0.040 inch thick with hemmed edges.

2.10 MISCELLANEOUS MATERIALS

- A. Sill-Sealer Gaskets (for dry masonry): Glass-fiber-resilient insulation, fabricated in strip form, for use as a sill sealer; 1-inch nominal thickness, compressible to 1/32 inch; selected from manufacturer's standard widths to suit width of sill members indicated.
- B. Sill-Sealer Gaskets (for damp conditions): Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to suit width of sill members indicated.
- C. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch.
- D. Water-Repellent Preservative: NWWDA-tested and -accepted formulation containing 3-iodo-2-propynyl butyl carbamate, combined with an insecticide containing chloropyrifos as its active ingredient.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
- B. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- C. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.
- D. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.

- E. Metal Framing Anchors: Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- F. Install sill sealer gasket to form continuous seal between sill plates and foundation walls.
- G. Do not splice structural members between supports unless otherwise indicated.
- H. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
 - 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.
- I. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
 - 1. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet o.c.
- J. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- K. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
 - 1. Use inorganic boron for items that are continuously protected from liquid water.
 - 2. Use copper naphthenate for items not continuously protected from liquid water.
- L. Securely attach rough carpentry work to substrate by anchoring and 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.
- M. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.
- N. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.
 - 1. Comply with approved fastener patterns where applicable. Before fastening, mark fastener locations, using a template made of sheet metal, plastic, or cardboard.
 - 2. Use finishing nails unless otherwise indicated. Countersink nail heads and fill holes with wood filler.
 - 3. Use common nails unless otherwise indicated. Drive nails snug but do not countersink nail heads.

3.2 WOOD GROUND, BLOCKING, AND NAILER INSTALLATION

- A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.
- C. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- D. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 WOOD FURRING INSTALLATION

- A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- B. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-3-inch nominal- (19-by-63-mm actual-) size furring horizontally and vertically at 24 inches (610 mm) o.c.
- C. Furring to Receive Gypsum Boar or Plaster Lath: Install 1-by-2-inch nominal- (19-by-38-mm actual-) size furring vertically at 16 inches (406 mm) o.c.

3.4 WALL AND PARTITION FRAMING INSTALLATION

- A. General: Provide single bottom plate and double top plates using members of 2-inch nominal thickness whose widths equal that of studs, except single top plate may be used for non-load-bearing partitions. Fasten plates to supporting construction unless otherwise indicated.
 - 1. For interior partitions and walls, provide 2-by-6-inch nominal- size wood studs spaced 16 inches o.c. unless otherwise indicated.
 - 2. Provide continuous horizontal blocking at mid-height of partitions more than 96 inches high, using members of 2-inch nominal thickness and of same width as wall or partitions.
- B. Construct corners and intersections with two studs at interior non-load-bearing partitions.
- C. Frame openings with multiple studs and headers. Provide nailed header members of thickness equal to width of studs. Support headers on jamb studs.
 - 1. For non-load-bearing partitions, provide double-jamb studs and headers not less than 4-inch nominal depth for openings 48 inches and less in width, 6-inch nominal depth for openings 48 to 72 inches in width, 8-inch nominal depth for openings 72 to 120 inches in width, and not less than 10-inch nominal depth for openings 10 to 12 feet in width.

3.5 RAFTER FRAMING INSTALLATION

- A. Rafters: Notch to fit exterior wall plates and toe nail or use metal framing anchors. Double rafters to form headers and trimmers at openings in roof framing, if any, and support with metal

hangers. Where rafters abut at ridge, place directly opposite each other and nail to ridge member or use metal ridge hangers.

1. At valleys, provide double-valley rafters of size indicated or, if not indicated, of same thickness as regular rafters and 2 inches deeper. Bevel ends of jack rafters for full bearing against valley rafters.
2. At hips, provide hip rafter of size indicated or, if not indicated, of same thickness as regular rafters and 2 inches deeper. Bevel ends of jack rafters for full bearing against hip rafter.

- B. Provide collar beams (ties) as indicated or, if not indicated, provide 1-by-6-inch nominal- size boards between every third pair of rafters, but not more than 48 inches o.c. Locate below ridge member, at third point of rafter span. Cut ends to fit roof slope and nail to rafters.
- C. Provide special framing as indicated for eaves, overhangs, dormers, and similar conditions if any.

3.6 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes sufficiently wet that moisture content exceeds that specified, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061000

SECTION 061600

SHEATHING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Wall sheathing.
 - 2. Roof sheathing.
 - 3. Sheathing joint and penetration treatment.

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 and fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements.

1.4 INFORMATIONAL SUBMITTALS

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: As tested according to ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 WOOD PANEL PRODUCTS

- A. Emissions: Products shall meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.3 PRESERVATIVE-TREATED PLYWOOD

- A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.
- B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
- C. Application: Treat all plywood unless otherwise indicated.

2.4 WALL SHEATHING

- A. Plywood Sheathing: Exterior, Exposure Grade 1 sheathing, in thickness indicated on drawings.
- B. Glass-Mat Gypsum Sheathing: ASTM C 1177/1177M.
 1. Manufacturers: Subject to compliance with the following, provide products by one of the following:
 - a. Georgia-Pacific Gypsum LLC.
 - b. USG Corporation.
 - c. National Gypsum.
 - d. USG Corporation.
 2. Type and Thickness: Regular, 1/4 inch (6.4 mm) thick and 1/2 inch (13 mm) thick.

2.5 ROOF SHEATHING

- A. Plywood Sheathing: Exterior, Structural I sheathing, in thickness indicated on drawings.

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. For roof and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M or of Type 304 stainless steel.

2.7 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

- A. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.
 - 1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2 inches (50 mm) wide, 10 by 10 or 10 by 20 threads/inch (390 by 390 or 390 by 780 threads/m), of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
- C. Securely attach to substrate by fastening as indicated, complying with the following:
 - 1. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
 - 2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in the ICC's International Residential Code for One- and Two-Family Dwellings.
 - 3. ICC-ES evaluation report for fastener.
- D. Coordinate wall and roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

END OF SECTION 061600

SECTION 061753

SHOP FABRICATED TRUSSES

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. Triangular-Pitched Roof Trusses
2. Scissor-Chord Roof Trusses, Top-Chord Bearing
3. Scissor-Chord Roof Trusses, Bottom-Chord Bearing
4. Truss Accessories

1.3 REFERENCES

- A. ASTM International Publications:

1. A153 "Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware"
2. A307 "Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength"
3. A563 "Standard Specification for Carbon and Alloy Steel Nuts"
4. A591 "Standard Specification for Steel Sheet, Electrolytic Zinc-Coated, for Light Coating Weight [Mass] Applications"
5. A653 "Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process"
6. A666 "Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar"
7. A780 "Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings"
8. A792 "Standard Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot-Dip Process"
9. F1667 "Standard Specification for Driven Fasteners: Nails, Spikes, and Staples"

- B. The American Society of Mechanical Engineers (ASME) Publications:

1. B18.2.1 "Square and Hex Bolts and Screws, Inch Series"

- C. American Wood-Preservers's Association (AWPA) Publications:

1. C2 "Lumber, Timber, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes"
2. C9 "Plywood - Preservative Treatment by Pressure Process Document Number"
3. M4 "Standard for the Care of Preservative-Treated Wood Products Document Number"

- D. Truss Plate Institute (TPI) / American National Standards Institute (ANSI) Publications:
1. ANSI/TP1 1, "National Design Standard for Metal-Plate-Connected Wood Truss Construction."
 2. TPI HIB "Commentary and Recommendations for Handling Installing & Bracing Metal Plate Connected Wood Trusses."
 3. TPI DSB "Recommended Design Specification for Temporary Bracing of Metal Plate Connected Wood Trusses."

1.4 DEFINITIONS

- A. Metal-plate-connected wood trusses include planar structural units consisting of metal-plate-connected members fabricated from dimension lumber and cut and assembled before delivery to Project site.

1.5 PERFORMANCE REQUIREMENTS/DELEGATED DESIGN

- A. Structural Performance: Engineer, fabricate, and erect metal-plate-connected wood trusses to withstand design loads within limits and under conditions required.
1. Design Loads: As indicated.
 2. Design trusses to withstand design loads without deflections greater than the following:
 - a. Roof Trusses: Vertical deflection of 1/240 of span due to total load.
 - b. Roof Trusses: Horizontal deflection at reactions of 1-1/4 inches due to total load.
 - c. Floor Trusses: Vertical deflection of 1/480 of span due to live load.
- B. Engineering Responsibility: Engage a fabricator who uses a qualified professional engineer to prepare calculations, Shop Drawings, and other structural data for metal-plate-connected wood trusses.

1.6 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections:
1. Product Data: For lumber, metal-plate connectors, metal framing connectors, bolts, and fasteners.
 2. Shop Drawings detailing location, pitch, span, camber, configuration, and spacing for each type of truss required; species, sizes, and stress grades of lumber to be used; splice details; type, size, material, finish, design values, and orientation and location of metal connector plates; and bearing details.
 - a. To the extent truss design considerations are indicated as fabricator's responsibility, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - b. Include truss Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation.
 3. Product certificates signed by officer of truss fabricating firm certifying that metal-plate-connected wood trusses supplied for Project comply with specified requirements and Shop Drawings.
 4. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with

project names and addresses, names and addresses of architects and owners, and other information specified.

5. Material test reports from a qualified independent testing agency indicating and interpreting test results relative to compliance of fire-retardant-treated wood products with requirements indicated.
6. Material certificates for dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the American Lumber Standards Committee (ALSC) Board of Review.
7. Wood treatment data as follows, including chemical treatment manufacturer's instructions for handling, storing, installing, and finishing treated materials:
 - a. For each type of preservative-treated wood product, include certification by treating plant stating type of preservative solution and pressure process used, net amount of preservative retained, and compliance with applicable standards.
 - b. For waterborne-treated products, include statement that moisture content of treated materials was reduced to levels indicated before shipment to truss fabricator.
 - c. For fire-retardant-treated wood products, include certification by treating plant that treated materials comply with specified standard and other requirements as well as data relative to bending strength, stiffness, and fastener-holding capacities of treated materials, all tested in accordance with ASTM D5664.
8. Research or evaluation reports of the model code organization acceptable to authorities having jurisdiction that evidence the following products' compliance with building code in effect for Project.
 - a. Fire-retardant-treated wood
 - b. Metal-plate connectors
 - c. Metal framing connectors

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer with a minimum of five years of experience, who has completed wood truss projects similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- B. Fabricator's Qualifications: Engage a firm that complies with the following requirements for quality control and is experienced in fabricating metal-plate-connected wood trusses similar to those indicated for this Project and with a record of successful in-service performance:
- C. Fabricator participates in a recognized quality-assurance program that involves inspection by SPIB; Timber Products Inspection, Inc.; Truss Plate Institute (TPI); or other independent inspecting and testing agency acceptable to Professional and authorities having jurisdiction. Comply with applicable requirements and recommendations of the following publications:
 1. ANSI/TP1 1
 2. TPI HIB
 3. TPI DSB
- D. Metal-Plate Connector Manufacturer's Qualifications: A manufacturer that is a member of TPI and that complies with TPI quality-control procedures for manufacture of connector plates published in ANSI/TP1 1.

- E. Single-Source Responsibility for Connector Plates: Provide metal connector plates from one source and by a single manufacturer.
- F. Wood Structural Design Standard: Comply with applicable requirements of AFPA's "Manual for The Wood Frame Construction Manual (WFCM) for One- and Two-Family Dwellings."
- G. Single-Source Engineering Responsibility: Provide trusses engineered by metal-plate connector manufacturer to support superimposed dead and live loads indicated, with design approved and certified by a qualified professional engineer.
- H. Professional Engineer Qualifications: A professional engineer who is legally authorized to practice in the jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated that have resulted in installing metal-plate- connected wood trusses similar to those indicated for this Project and with a record of successful in-service performance.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Handle and store trusses with care and comply with manufacturer's written instructions and TPI recommendations to avoid damage and lateral bending.
- B. Inspect trusses showing discoloration, corrosion, or other evidence of deterioration. Discard and replace trusses that are damaged or defective.

1.9 SEQUENCING AND SCHEDULING

- A. Time delivery and erection of trusses to avoid extended on-site storage and to avoid delaying progress of other trades whose work must follow erection of trusses.

PART 2 - PRODUCTS

2.1 DIMENSION LUMBER

- A. Lumber Standards: Comply with DOC PS 20, "American Softwood Lumber Standard," and with applicable grading rules of inspection agencies certified by ALSC's Board of Review.
- B. Inspection Agencies: Inspection agencies, and the abbreviations used to reference them, include the following:
 1. Northeastern Lumber Manufacturers Association (NELMA)
 2. National Lumber Grades Authority (Canadian) (NLGA)
 3. Southern Pine Inspection Bureau (SPIB)
 4. West Coast Lumber Inspection Bureau (WCLIB)
 5. Western Wood Products Association (WWPA)
- C. Grade Stamps: Provide lumber with each piece factory marked with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.
- D. Provide dressed lumber, S4S, manufactured to actual sizes required by DOC PS 20 for moisture content specified, to comply with requirements indicated below:

1. Provide dry lumber with 19 percent maximum moisture content at time of dressing.
- E. Grade and Species: Provide dimension lumber of any species for truss chord and web members, graded visually or mechanically, and capable of supporting required loads without exceeding allowable design values according to AFPA's "National Design Specification for Wood Construction" and its "Supplement."

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. General: Where lumber is indicated as preservative treated or is specified to be treated, comply with applicable requirements of AWPA C2 (lumber). Mark each treated item with the Quality Mark Requirements of an inspection agency approved by ALSC's Board of Review.
1. Lumber that is not in contact with the ground and is not used in areas subject to water comply with AWPA C31 with inorganic boron (SBX).
 2. Do not use chemicals containing chromium or arsenic.
- B. Pressure treat aboveground items with waterborne preservatives to a minimum retention of 0.25 lb/cu. ft. After treatment, kiln-dry lumber to a maximum moisture content of 19 percent.
- C. Complete fabrication of treated items before treatment, where possible. If cut after treatment, apply field treatment complying with AWPA M4 to cut surfaces. Inspect each piece of lumber after drying and discard damaged or defective pieces.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. Accepted Manufacturers or equal as approved by the Professional:
1. Fire-Retardant-Treated Materials, Interior Type A:
 - a. Hoover Treated Wood Products, Inc. (877-722-6292, ext. 211)
 - b. "FirePRO"; Osmose, Inc. (800-241-0240)
 2. Fire-Retardant-Treated Materials, Exterior Type:
 - a. Hoover Treated Wood Products, Inc. (877-722-6292, ext. 211)
- B. General: Where fire-retardant-treated wood is indicated, comply with applicable requirements of AWPA C20 (lumber). Identify fire-retardant-treated wood with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.
1. Research or Evaluation Reports: Provide fire-retardant-treated wood acceptable to authorities having jurisdiction and for which a current model code research or evaluation report exists that evidences compliance of fire-retardant-treated wood for application indicated.
- C. Interior Type A: For interior locations, use chemical formulation that produces treated lumber with the following properties under conditions present after installation:
1. Bending strength, stiffness, and fastener-holding capacities are not reduced below values published by manufacturer of chemical formulation under elevated temperature and humidity conditions simulating installed conditions when tested by a qualified independent testing agency.

2. No form of degradation occurs due to acid hydrolysis or other causes related to treatment.
 3. Contact with treated wood does not promote corrosion of metal fasteners.
- D. Exterior Type: Use for exterior locations and where indicated.
- E. Inspect each piece of treated lumber after drying and discard damaged or defective pieces.
- 2.4 METAL CONNECTOR PLATES
- A. Accepted Manufacturers or equal as approved by the Professional:
1. Metal Connector Plates:
 - a. Alpine Engineered Products, Inc. (800-735-8055)
 - b. Mitek Industries, Inc. (800-325-8075)
 - c. Truswal Systems Corporation (800-521-9790)
 - d. USP Lumber Connectors (800-328-5934)
- B. General: Fabricate connector plates from metal complying with requirements indicated below.
- C. Interior locations:
1. Hot-Dip Galvanized Steel Sheet: Structural-quality steel sheet, zinc coated by hot-dip process complying with ASTM A653, Structural Steel, (SS), high strength low alloy steel, Type A, G60 coating designation; Grade 33 and not less than 0.0359 inch thick.
 2. Electrolytic Zinc-Coated Steel Sheet: ASTM A591, structural-(physical) quality steel sheet, zinc coated by electrodeposition; 33,000-psi minimum yield strength, coating class C, and not less than 0.0474 inch thick.

2.5 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified below for material and manufacture.
1. Where truss members are exposed to weather, in ground contact or in high humidity areas, provide fasteners of stainless steel, Type 304 or 316.
- B. Nails, Wire, Brads, and Staples: ASTM F1667.
- C. Power-Driven Fasteners: ICC NER-272.
- D. Wood Screws: ASME B18.2.1.
- E. Lag Bolts and Screws: ASME B18.2.1.
- F. Bolts: Steel bolts complying with ASTM A307, Grade A; with ASTM A563 hex nuts and, where indicated, flat washers.
- G. Truss Tie-Downs: Bent strap tie for fastening roof trusses to wall studs below, 1-1/2 inches wide by 0.050 inch thick. Tie fastens to one side of truss, top plates, and side of stud below.
- H. Truss Tie-Downs (Hurricane or Seismic Ties): Bent strap tie for fastening roof trusses to wall

studs below, 2-1/4 inches wide by 0.062 inch thick. Tie fits over top of truss and fastens to both sides of truss, top plates, and one side of stud below.

- I. Roof Truss Clips: Angle clips for bracing bottom chord of roof trusses at non-load-bearing walls, 1-1/4 inches wide by 0.050 inch thick. Clip is fastened to truss through slotted holes to allow for truss deflection.
- J. Floor Truss Hangers: U-shaped hangers, full depth of floor truss, with 1-3/4-inch- long seat; formed from metal strap 0.062 inch thick with tabs bent to extend over and be fastened to supporting member.

2.6 METAL FRAMING ANCHORS

- A. Accepted Manufacturers or equal as approved by the Professional:
 - 1. Metal Framing Anchors:
 - a. Hilti, Inc. (800-879-8000)
 - b. Cleveland Steel Specialty Co. (800-251-8351)
 - c. USP Lumber Connectors (800-328-5934)
 - d. Simpson Strong-Tie Company, Inc. (800-999-5099)
 - e. EMCO/Southeastern Metals/A Gibraltar Co. (800-690-7235)
- B. General: Provide metal framing anchors of structural capacity, type, size, metal, and finish indicated that comply with requirements specified, including the following:
 - 1. Research or Evaluation Reports: Provide products for which model code research or evaluation reports exist that are acceptable to authorities having jurisdiction and that evidence compliance of metal framing anchors for application indicated with building code in effect for this Project.
 - 2. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.
- C. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653, G60 coating designation; structural, commercial, or lock-forming quality, as standard with manufacturer for type of anchor indicated.
- D. Stainless-Steel Sheet: ASTM A666, Type 304 or 316, chromium nickel steel sheet; 33,000- psi minimum yield strength.

2.7 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight.
- B. Protective Coatings: Provide one of the following coating systems:
 - 1. SSPC-Paint 22, epoxy-polyamide primer.
 - 2. SSPC-Paint 16, coal-tar epoxy-polyamide black or dark red paint.

2.8 FABRICATION

- A. Cut truss members to accurate lengths, angles, and sizes to produce close-fitting joints.
- B. Fabricate metal connector plates to size, configuration, thickness, and anchorage details required to withstand design loadings for types of joint designs indicated.
- C. Assemble truss members in design configuration indicated using jigs or other means to ensure uniformity and accuracy of assembly with joints closely fitted to comply with tolerances of ANSI/TP1 1. Position members to produce design camber indicated.
- D. Fabricate wood trusses within manufacturing tolerances of ANSI/TP1 1.
- E. Connect truss members by metal connector plates located and securely embedded simultaneously into both sides of wood members by air or hydraulic press.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Do not install wood trusses until supporting construction is in place and is braced and secured.
- B. Before installing, splice trusses delivered to Project site in more than one piece.
- C. Hoist trusses in place by lifting equipment suited to sizes and types of trusses required, exercising care not to damage truss members or joints by out-of-plane bending or other causes.
- D. Install and brace trusses according to recommendations of TPI and as indicated.
- E. Install trusses plumb, square, and true to line and securely fasten to supporting construction.
- F. Space, adjust, and align trusses in location before permanently fastening and as indicated on Drawings.
- G. Anchor trusses securely at all bearing points using metal framing anchors. Install fasteners through each fastener hole in metal framing anchor according to manufacturer's fastening schedules and written instructions.
- H. Securely connect each truss ply required for forming built-up girder trusses.
 - 1. Anchor trusses to girder trusses as indicated on Drawings.
- I. Install and fasten permanent bracing during truss erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.
 - 1. Install and fasten strongback bracing vertically against vertical web of parallel-chord floor trusses at centers indicated on Drawings.
- J. Install wood trusses within installation tolerances of ANSI/TP1 1.
- K. Do not cut or remove truss members.

L. Return wood trusses that are damaged or do not meet requirements to fabricator and replace with trusses that do meet requirements.

1. Do not alter trusses in the field.

3.2 REPAIRS AND PROTECTION

A. Repair damaged galvanized coatings on exposed surfaces with galvanized repair paint according to ASTM A780 and manufacturer's written instructions.

B. Protective Coating: Clean and prepare exposed surfaces of embedded-metal connector plates. Brush apply primer, when part of coating system, and one coat of protective coating.

1. Apply materials to provide minimum dry film thickness recommended by manufacturer of coating system.

END OF SECTION 061753

SECTION 061800

GLUED-LAMINATED CONSTRUCTION

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions to the Construction Contract 2017 Edition", "Special Conditions" and "Division 01- General Requirements" 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. Drawings, 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 framing using structural glued-laminated timber.
- B. Related Requirements:
 - 1. Section 061000 "Rough Carpentry" for dimension lumber items associated with structural glued-laminated timber.
 - 2. Section 061300 "Heavy Timber Construction" for framing using timbers.
 - 3. Section 061516 "Wood Roof Decking" for glued-laminated wood roof decking.

1.3 DEFINITIONS

- A. Structural Glued-Laminated (Glulam) Timber: An engineered, stress-rated timber product assembled from selected and prepared wood laminations bonded together with adhesives and with the grain of the laminations approximately parallel longitudinally.

1.4 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include data on lumber, adhesives, fabrication, and protection.
 - 2. For preservative-treated wood products. Include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
 - 3. For connectors. Include installation instructions.
- B. Sustainable Design Submittals:
 - 1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
 - 2. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
 - 3. Chain-of-Custody Qualification Data: For manufacturer and vendor.
 - 4. Product Data: For laminating adhesives, indicating that product contains no urea formaldehyde.
 - 5. Laboratory Test Reports: For laminating adhesives, indicating compliance with

requirements for low-emitting materials.

- C. Shop Drawings:
 - 1. Show layout of structural glued-laminated timber system and full dimensions of each member.
 - 2. Indicate species and laminating combination.
 - 3. Include large-scale details of connections.
- D. Samples: Full width and depth, 24 inches long, showing the range of variation to be expected in appearance of structural glued-laminated timber.
 - 1. Apply specified factory finish to three sides of half length of each Sample.
- E. Delegated-Design Submittal: For structural glued-laminated timber and timber connectors.
- F. Certificates of Conformance: Issued by a qualified testing and inspecting agency indicating that structural glued-laminated timber complies with requirements in AITC A190.1.
- G. Material Certificates: For preservative-treated wood products, from manufacturer. Indicate type of preservative used and net amount of preservative retained.
- H. Research/Evaluation Reports: For structural glued-laminated timber and timber connectors, from ICC-ES.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: An AITC- or APA-EWS-licensed firm certified for chain of custody by an FSC-accredited certification body.
- B. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
- C. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. General: Comply with provisions in AITC 111.
- B. Individually wrap members using plastic-coated paper covering with water-resistant seams.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design structural glued-laminated timber and connectors.
- B. Structural Performance: Structural glued-laminated timber and connectors shall withstand the effects of structural loads shown on Drawings without exceeding allowable design working stresses listed in AITC 117 or determined according to ASTM D 3737 and acceptable to

authorities having jurisdiction.

- C. Seismic Performance: Structural glued-laminated timber and connectors shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.2 STRUCTURAL GLUED-LAMINATED TIMBER

- A. General: Provide structural glued-laminated timber that complies with AITC A190.1 and AITC 117 or research/evaluation reports acceptable to authorities having jurisdiction.
 - 1. Factory mark each piece of structural glued-laminated timber with AITC Quality Mark or APA-EWS trademark. Place mark on surfaces that are not exposed in the completed Work.
 - 2. Provide structural glued-laminated timber made from single species.
 - 3. Provide structural glued-laminated timber made from solid lumber laminations; do not use laminated veneer lumber.
 - 4. Provide structural glued-laminated timber made with wet-use adhesive complying with AITC A190.1.
 - 5. Adhesives: Do not use adhesives that contain urea formaldehyde.
 - 6. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Regional Materials: Wood products shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.
- C. Regional Materials: Wood products shall be manufactured within 500 miles of Project site.
- D. Certified Wood: Wood products shall be certified as "FSC Pure" or "FSC Mixed Credit" according to FSC STD-01-001 and FSC STD-40-004.
- E. Species and Grades for Structural Glued-Laminated Timber: Southern pine in grades needed to comply with "Performance Requirements" Article.
- F. Species and Grades for Beams:
 - 1. Species and Beam Stress Classification: Southern pine, 24F-1.8E.
 - 2. Lay-up: Either balanced or unbalanced.
- G. Species and Grades for Columns:
 - 1. Species and Combination Symbol: Southern pine, 50
- H. Appearance Grade: Architectural, complying with AITC 110.
 - 1. For Premium and Architectural appearance grades, fill voids as required by AITC 110.

2.3 TIMBER CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the

following or equal as approved by the Professional:

1. Cleveland Steel Specialty Co.
 2. Simpson Strong-Tie Co., Inc.
 3. USP Structural Connectors.
- B. Fabricate beam seats from steel with 3/8-inch bearing plates, 3/4-inch-diameter-by-12-inch-long deformed bar anchors, and 0.239-inch side plates.
- C. Fabricate arch base shoes from steel with 1-inch baseplates and 3/8-inch side plates.
- D. Fabricate beam hangers from steel with 0.179-inch stirrups and 0.239-inch top plates.
- E. Fabricate hinge connectors from steel with 0.179-inch side plates and 3/4-inch top and bottom plates.
- F. Fabricate strap ties from steel, 2-1/2 inches wide by 0.179 inch thick.
- G. Fabricate tie rods from round steel bars with upset threads connected with forged-steel turnbuckles complying with ASTM A 668/A 668M.
- H. Provide bolts, 3/4 inch unless otherwise indicated, complying with ASTM A 307, Grade A; nuts complying with ASTM A 563; and, where indicated, flat washers.
- I. Provide shear plates, 2-5/8 inches in diameter, complying with ASTM D 5933.
- J. Materials: Unless otherwise indicated, fabricate from the following materials:
1. Structural-steel shapes, plates, and flat bars complying with ASTM A 36/A 36M.
 2. Round steel bars complying with ASTM A 575, Grade M 1020.
 3. Hot-rolled steel sheet complying with ASTM A 1011/A 1011M, Structural Steel, Type SS, Grade 33.
 4. Stainless-steel plate and flat bars complying with ASTM A 666, Type 304.
 5. Stainless-steel bars and shapes complying with ASTM A 276, Type 304.
 6. Stainless-steel sheet complying with ASTM A 240/A 240M or ASTM A 666, Type 304.
- K. Finish steel assemblies and fasteners with rust-inhibitive primer, 2-mil dry film thickness.
- L. Hot-dip galvanize steel assemblies and fasteners after fabrication to comply with ASTM A 123/A 123M or ASTM A 153/A 153M.

2.4 MISCELLANEOUS MATERIALS

- A. End Sealer: Manufacturer's standard, transparent, colorless wood sealer that is effective in retarding the transmission of moisture at cross-grain cuts and is compatible with indicated finish.
- B. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.

2.5 FABRICATION

- A. Shop fabricate for connections to greatest extent possible, including cutting to length and drilling bolt holes.
 - 1. Dress exposed surfaces as needed to remove planing and surfacing marks.
- B. Camber: Fabricate horizontal and inclined members of less than 1:1 slope with either circular or parabolic camber equal to 1/500 of span.
- C. Where preservative-treated members are indicated, fabricate (cut, drill, surface, and sand) before treatment to greatest extent possible. Where fabrication must be done after treatment, apply a field-treatment preservative to comply with AWPA M4.
 - 1. Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
 - 2. Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.
- D. End-Cut Sealing: Immediately after end cutting each member to final length, apply a saturation coat of end sealer to ends and other cross-cut surfaces, keeping surfaces flood coated for not less than 10 minutes.
- E. Seal Coat: After fabricating, sanding, and end-coat sealing, apply a heavy saturation coat of penetrating sealer on surfaces of each unit.

2.6 FACTORY FINISHING

- A. Wiped Stain Finish: Manufacturer's standard, dry-appearance, penetrating acrylic stain and sealer; oven dried and resistant to mildew and fungus.
 - 1. Color: As selected by Architect from manufacturer's full range.
- B. Clear Finish: Manufacturer's standard, two-coat, clear varnish finish; resistant to mildew and fungus.

PART 3 - EXECUTION

3.1 EXAMINATION

- 3.2 Examine substrates in areas to receive structural glued-laminated timber, with Installer present, for compliance with requirements, installation tolerances, and other conditions affecting performance of the Work.

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

3.4 INSTALLATION

- A. General: Erect structural glued-laminated timber true and plumb and with uniform, close-fitting joints. Provide temporary bracing to maintain lines and levels until permanent supporting members are in place.
 - 1. Handle and temporarily support glued-laminated timber to prevent surface damage, compression, and other effects that might interfere with indicated finish.

- B. Framing Built into Masonry: Provide 1/2-inch clearance at tops, sides, and ends of members built into masonry; bevel cut ends 3 inches; and do not embed more than 4 inches unless otherwise indicated.
- C. Cutting: Avoid extra cutting after fabrication. Where field fitting is unavoidable, comply with requirements for shop fabrication.
- D. Fit structural glued-laminated timber by cutting and restoring exposed surfaces to match specified surfacing and finishing.
 - 1. Predrill for fasteners using timber connectors as templates.
 - 2. Finish exposed surfaces to remove planing or surfacing marks and to provide a finish equivalent to that produced by machine sanding with No. 120 grit sandpaper.
 - 3. Coat cross cuts with end sealer.
 - 4. Where preservative-treated members must be cut during erection, apply a field-treatment preservative to comply with AWWA M4.
 - a. Use inorganic boron (SBX) treatment for members not in contact with the ground and continuously protected from liquid water.
 - b. Use copper naphthenate treatment for members in contact with the ground or not continuously protected from liquid water.
- E. Install timber connectors as indicated.
 - 1. Unless otherwise indicated, install bolts with same orientation within each connection and in similar connections.
 - 2. Install bolts with orientation as indicated or, if not indicated, as directed by Architect.

3.5 ADJUSTING

- A. Repair damaged surfaces and finishes after completing erection. Replace damaged structural glued-laminated timber if repairs are not approved by Architect.

3.6 PROTECTION

- A. Do not remove wrappings on individually wrapped members until they no longer serve a useful purpose, including protection from weather, sunlight, soiling, and damage from work of other trades.
 - 1. Coordinate wrapping removal with finishing work. Retain wrapping where it can serve as a painting shield.
 - 2. Slit underside of wrapping to prevent accumulation of moisture inside the wrapping.

END OF SECTION 061800

SECTION 064000

ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Quartz Interior Countertops.
 - 2. Wood furring, blocking, shims, and hanging strips for installing interior architectural woodwork items that are not concealed within other construction.
 - 3. Shop priming of interior architectural woodwork.
 - 4. Composite Board Exterior Countertops.

1.3 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Anchors.
 - 2. Adhesives.
 - 3. Shop finishing materials.
- B. Sustainable Design Submittals:
 - 1. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 - 2. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings:
 - 1. Include the following:
 - a. Dimensioned plans, elevations, and sections.
 - b. Attachment details.
 - 2. Show locations and sizes of furring, blocking, and hanging strips, including blocking and reinforcement concealed by construction and specified in other Sections.
- D. Samples: For each exposed product and for each shop-applied color and finish specified.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For architectural woodwork manufacturer and Installer.
- B. Product Certificates: For the following:
 - 1. Composite wood and agrifiber products.
 - 2. Adhesives.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data.

1.6 QUALITY ASSURANCE

- A. Manufacturer's Certification: Licensed participant in AWI's Quality Certification Program.
 - 1. Installer Qualifications: Manufacturer of products and Licensed participant in AWI's Quality Certification Program.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install interior architectural woodwork until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels designed for building occupants for 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.
- C. Reinforcement: Coordinate, locate and provide concealed framing, blocking and reinforcements that support woodwork by field measurements before being enclosed and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 ARCHITECTURAL WOODWORK, GENERAL

- A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.
- B. Basis of Design Product: Subject to compliance with requirements, provide products by manufacturers listed below, or a comparable product meeting all requirements.

2.2 RESTROOM COUNTERTOPS

- A. Application: Sink counters as indicated on drawings
 - 1. Natural quartz countertops
 - 2. Manufacturer: Basis of Design Product: Corian Quartz, or comparable product by one of the following:
 - a. Wilsonart Quartz
 - b. Colorquartz
 - 3. Color: To be selected from Corian's price range 1 through 3 or comparable price range categories from other manufacturers.
 - 4. Thickness: 2cm for counter
 - 5. Edge: ¼" Bevel
 - a. Finish edges at countertop cutouts

2.3 EXTERIOR COUNTERTOPS

- A. Application: Composite wood board countertops and trim with pressure treated wood framing at exterior sinks.
 - 1. Composite board countertops
 - 2. Manufacturer: Basis of Design Product: Trex Company, Trex Select Square Edge Board or comparable product by one of the following:
 - a. Duralife Decking
 - b. Calibamboo
 - 3. Size:
 - a. Boards: 2" x 6" nominal thickness
 - 4. Fastening: provide manufacturer's standard hidden fastening system and stainless steel or non-corroding fasteners.

2.4 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Nailers: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.
 - 1. Preservative Treatment: Provide softwood lumber treated by pressure process, AWPA U1; Use Category UC3b.
 - a. Provide where in contact with concrete or masonry.
 - b. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent.
 - c. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
 - d. Mark lumber with treatment quality mark of an inspection agency approved by the American Lumber Standards Committee's (ALSC) Board of Review.
- B. Provide self-drilling screws for metal-framing supports, as recommended by metal-framing manufacturer.
- C. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage.
 - 1. Provide metal expansion sleeves or expansion bolts for post-installed anchors.

2. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.
- D. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 - E. Installation Adhesive: Product recommended by fabricator for each substrate for secure anchorage.
 1. Adhesives shall have a VOC content of 70 g/L or less.
 2. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.5 FABRICATION

- A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
- B. Complete fabrication, including assembly, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide allowance for scribing, trimming, and fitting.
- C. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
- D. 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.

2.6 SHOP PRIMING

- A. Preparations for Finishing: Comply with the Architectural Woodwork Standards for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing interior architectural woodwork, as applicable to each unit of work.
- B. Interior Architectural Woodwork for Opaque Finish: Shop prime with one coat of wood primer as specified in Section 099123 "Interior Painting."
 1. Backpriming: Apply one coat of primer, compatible with finish coats, to concealed surfaces of woodwork.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition interior architectural woodwork to humidity conditions in installation areas for not less than 72 hours prior to beginning of installation.
- B. Before installing interior architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming of concealed surfaces.

3.2 COUNTERTOP INSTALLATION

- A. Install components plumb, level, and true, or according to approved shop drawings and manufacturer's published installation instructions. Use woodworking and specialized fabrication tools acceptable to manufacturer.
- B. Form joint seams and built-up edges with specified seam adhesive. Seams to be inconspicuous in completed work. Seams in locations shown on approved shop drawings and acceptable to manufacturer. Promptly remove excess adhesive.
- C. Provide minimum 1/2 inch radius for countertop inside corners.
- D. Fill gaps between countertop and terminating substrates with sealant, as specified in "079200 JOINT SEALANTS."
- E. Anchor securely by screwing through corner blocks of base cabinets, wall blocking/reinforcement, or other supports into underside of countertop. Where backsplash is indicated, caulk space between backsplash and wall with sealant specified in Division 07 Section "Joint Sealants."

END OF SECTION 064000

SECTION 071416

COLD FLUID-APPLIED WATERPROOFING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Single-component, cold-applied, liquid waterproofing membrane.
 - 2. Prefabricated drainage system.

1.3 REFERENCES

- A. ASTM D146-97 - Standard Test Methods for Sampling and Testing Bitumen- Saturated Felts and Fabrics Used in Roofing and Waterproofing.
- B. ASTM D412-98a(2002)e1 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
- C. ASTM E96-00e1 (Method B) - Standard Test Methods for Water Vapor Transmission of Materials.
- D. ASTM C836 - Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course.

1.4 PREINSTALLATION MEETINGS

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

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Show locations and extent of waterproofing.

2. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.

C. Samples: For the following products:

1. Flashing sheet, 10 by 8 inches (250 by 200 mm).
2. Membrane-reinforcing fabric, 10 by 8 inches (250 by 200 mm).
3. Drainage panel, 4 by 4 inches (100 by 100 mm).

1.6 INFORMATIONAL SUBMITTALS

- A. Sample warranty.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.
- B. Source Limitations: Obtain waterproofing materials, protection course and molded-sheet drainage panels from single source from single manufacturer.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Product not intended for uses subject to abuse or permanent exposure to the elements.
- B. Do not apply membrane when air, material, or surface temperatures are expected to fall below 30° F (-1° C) within four hours of completed application
- C. Do not apply membrane if rainfall is forecast or imminent within 12 hours.
- D. Do not apply to frozen concrete. Membrane can be applied to green concrete.

1.9 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace waterproofing that fails in materials or workmanship within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SINGLE COMPONENT POLYMER-MODIFIED WATERPROOFING

- A. Single-Component, Modified Polyurethane Waterproofing: Comply with ASTM C 836 and with manufacturer's written physical requirements.

1. Basis of Design: Subject to compliance with requirements, provide W.R. Meadows, Inc., MEL-ROL LM Waterproofing System comparable product by one of the following:
 - a. Tremco.
 - b. GCP Applied Technologies Inc. (formerly Grace Construction Products).
 - c. Carlisle Coatings and Waterproofing, Inc.
2. Waterproofing membrane shall have the following properties as determined by laboratory testing:
 - a. Color: Black
 - b. Solids: 70%
 - c. Total Cure Time: 16-24 hours.
 - d. Elongation, ASTM D412: 1500%
 - e. Water Absorption, ASTM D1970: 0.7%
 - f. Water Vapor Transmission, ASTM E96 (Method B): 0.03 perms

2.2 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials recommended by manufacturer to be compatible with one another and with waterproofing, as demonstrated by waterproofing manufacturer, based on testing and field experience.
- B. Primer: Not required for concrete.
- C. Concrete Repair Materials:
 1. Manufacturer's recommended concrete repair mortars.
- D. Waterproofing Protection Course: As recommended by manufacturer as part of waterproofing system.
- E. Sheet Flashing: Manufacturer's recommended contact adhesive.

2.3 PREFABRICATED DRAINAGE SYSTEM

- A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Composite subsurface drainage panel consisting of a dimpled, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21-mm) sieve laminated to one side of the core and a polyethylene sheet bonded to the other side; and with a vertical flow rate through the core of 9 to 21 gpm per ft. (112 to 261 L/min. per m).
 1. Basis-of-Design Product: Subject to compliance with requirements, provide W.R. Meadows, Inc. MEL-DRAIN 5012-B or a comparable product by one of the following:
 - a. Tremco.
 - b. GCP Applied Technologies Inc. (formerly Grace Construction Products).
 - c. Carlisle Coatings & Waterproofing, Inc.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.
- B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.
- C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, acid residues, and other penetrating contaminants or film-forming coatings from concrete.
- D. Remove fins, ridges, and other projections, and fill honeycomb, aggregate pockets, holes, and other voids.
- E. Prepare surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, sleeves, and corners according to waterproofing manufacturer's written instructions and to recommendations in ASTM C898/C898M and ASTM C1471/C1471M.
- F. Prepare, treat, rout, and fill joints and cracks in substrate according to waterproofing manufacturer's written instructions and to recommendations in ASTM C898/C898M and ASTM C1471/C1471M. Before coating surfaces, remove dust and dirt from joints and cracks according to ASTM D4258.
- G. Apply primer coat per manufacturer's recommendations. Allow primer coat to dry before proceeding to membrane application.

3.2 WATERPROOFING APPLICATION

- A. Apply waterproofing according to manufacturer's written instructions and to recommendations in ASTM C898/C898M and ASTM C1471/C1471M.
- B. Unreinforced Waterproofing Applications.
 - 1. Apply one or more coats of waterproofing to obtain a seamless membrane free of entrapped gases and pinholes, with a dry film thickness of 60 mils (1.5 mm).
 - 2. Apply waterproofing to prepared wall terminations and vertical surfaces.

3.3 PREFABRICATED DRAINAGE SYSTEM

- A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, according to manufacturer's written instructions. Use adhesive or another method that does not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.
 - 1. For vertical applications, install protection course before installing drainage panels.

3.4 PROTECTION

- A. Do not permit foot or vehicular traffic on unprotected membrane.
- B. Protect waterproofing from damage and wear during remainder of construction period.
- C. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.
- D. Backfill immediately using care to avoid damaging drainage layer and to ensure permanent placement of the drainage board.

END OF SECTION 071416

SECTION 072100

THERMAL INSULATION

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:

1. Mineral wool board insulation at exterior cavity walls and foundation walls.
2. Mineral wool batt insulation at wood framed walls.
3. Semi-rigid mineral wool batt insulation at roof.
4. Insulation netting for installation at roof.

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

1. Under slab insulation specified with radiant floor piping, section 238316 “Radiant Floor Hydronic Piping.”

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Research reports.

PART 2 - PRODUCTS

2.1 MINERAL-WOOL BOARD INSULATION

- A. Basis of Design Product: Subject to compliance with requirements, provide Rockwool Comfortboard 80 or a comparable product by one of the following:

1. Johns Manville, a Berkshire Hathaway company.
 2. Thermafiber, Inc; an Owens Corning Company.
- B. Unfaced, Mineral-Wool Board Insulation: ASTM C 612; Type IVB.
- C. Fire Performance:
1. Surface Burning Characteristics to ASTM E 84:
 - a. Flame spread: 0
 - b. Smoke developed: 0
- D. Thermal Resistance (R value/inch at 75 degrees F): 4.0 hr ft/Btu to ASTM C518.
- E. Moisture Resistance:
1. Moisture absorption: 0.05% maximum to ASTM C1104/C1104M.
 2. Water vapor transmission: 31 perm to ASTM E96, Desiccant Method.
- F. Corrosive Resistance:
1. Steel to ASTM C665: Non-corrosive
 2. Stainless Steel to ASTM C795: Non-corrosive
- G. Density: 8.0 lb/cu ft to ASTM C303
- H. Compressive Strength: to ASTM C165
1. 439 psf at 10%
 2. 1065 psf at 25%
- I. Recycled Content: 40% minimum
- J. Fungi Resistance: To ASTM C1338

2.2 MINERAL-WOOL BATT INSULATION

- A. Mineral-Wool Blanket Insulation, Unfaced ASTM C665, Type I (blankets without membrane facing); consisting of fibers; passing ASTM E136 for combustion characteristics.
- B. Basis of Design: Manufacturer: Subject to compliance with requirements, provide Rockwool Comfortbatt or a comparable product by one of the following:
1. Johns Manville; a Berkshire Hathaway company.
 2. Thermafiber, Inc; an Owens Corning Company
- C. Fire Performance:
1. Surface Burning Characteristics: To ASTM E84
 - a. Flame spread: 0

- b. Smoke developed: 0
- D. Thermal Resistance: To ASTM C518
- E. Density: 2 lb/ cu ft to ASTM C167
- F. Recycled Content: 40% minimum

2.3 ACCESSORIES

- A. Insulation for Miscellaneous Voids:
 - 1. Mineral Wool Insulation: ASTM C665, Type I; with maximum flame-spread and smoke-developed indexes of 0, per ASTM E84.
- B. Insulation Netting: Non-metallic, polypropylene 1/6 -inch (6 strands per inch) mesh insulation netting, to be installed between roof trusses to suspend roof insulation below deck.
- C. Mechanical fasteners in accordance with insulation manufacturer's written recommendations.
- D. 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. Adhesives should have a VOC content of 70 g/L or less.
- E. Eave Ventilation Troughs: Preformed, rigid fiberboard or plastic sheets designed and sized to fit between roof framing members and to provide ventilation between insulated attic spaces and vented eaves.

PART 3 - EXECUTION

3.1 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.

3.2 INSTALLATION OF FOUNDATION WALL INSULATION

- A. Butt panels together for tight fit.
- B. Anchor Installation: Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors.
- C. Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing according to manufacturer's written instructions.

3.3 INSTALLATION OF CAVITY-WALL INSULATION

- A. Mineral-Wool Board Insulation: Install insulation fasteners 4 inches (100 mm) from each corner of board insulation, at center of board, and as recommended by manufacturer.
 - 1. Fit courses of insulation between masonry wall ties and other obstructions, with edges butted tightly in both directions, and with faces flush.
 - 2. Press units firmly against inside substrates.

3.4 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 (76-mm) clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
 - 4. For wood-framed construction, install blankets according to ASTM C1320 and as follows:
 - a. With faced blankets having stapling flanges, lap blanket flange over flange of adjacent blanket to maintain continuity of vapor retarder once finish material is installed over it.
- 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. (40 kg/cu. m).
 - 2. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.5 INSTALLATION OF INSULATION AT ROOF

- A. Semi-Rigid Blanket Insulation: Install in cavities formed by roof 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, cut and fit insulation that will produce a snug fit between ends.
2. Staple insulation mesh between wood truss members for support without compressing the insulation.
3. Mechanical fasteners that penetrate the roof sheathing from the underside are not acceptable.
4. Roofs: Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.

END OF SECTION 072100

SECTION 072600
VAPOR RETARDERS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Underslab polyethylene vapor retarders.
- B. Related Sections:
 - 1. Section 033000 “Concrete.”
 - 2. Section 238316 “Radiant Floor Hydronic Piping.”

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Product test reports.

PART 2 - PRODUCTS

2.1 POLYETHYLENE VAPOR RETARDERS

- A. Polyethylene Film: ASTM E1745, 15 mils (0.15 mm) thick minimum, with the following performance requirements:
 - 1. Maximum Water Vapor Permance, per ASTM E96 (Method B): 0.02 perms
 - 2. Puncture Resistance, per ASTM D1709: > 2200 grams.
 - 3. Radon Diffusion Coefficient, per k124/02/95: 8.8×10^{-12} m²/s
 - 4. Tensile Strength, per ASTM E154 Section 9: 84 Lb. Force/Inch.
- B. Manufacturer: Provide product by W.R. Meadows, Inc. PERMINATOR HP, or comparable product by one of the following:
 - 1. Stego Industries, LLC

2. Reef Industries, Inc.
- C.
1. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

PART 3 - EXECUTION

3.1 INSTALLATION OF VAPOR RETARDERS ON FRAMING

- A. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm) respectively. Continuously seal side and end laps with tape.
- 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.

END OF SECTION 072600

SECTION 072726

FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fluid-applied air and weather barriers.
 - 2. Transition membrane flashing.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Product certificates.
- B. Product test reports.
- C. Field quality-control reports.

1.6 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

- A. VOC Content: 100 g/L or less.

2.2 PERFORMANCE REQUIREMENTS

- A. Air-Barrier Performance: Air-barrier assembly and seals with adjacent construction shall be capable of performing as a continuous air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.
- B. Air-Barrier Assembly Air Leakage: Maximum 0.04 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft. (0.2 L/s x sq. m of surface area at 75 Pa), when tested according to ASTM E2357.

2.3 AIR BARRIERS, VAPOR IMPERMEABLE

- A. Vapor-Impermeable Air and Weather Barrier: Single component, asphalt-free, cold applied liquid moisture barrier with an installed dry film thickness, according to manufacturer's written instructions, of 40 mils or thicker over smooth, void-free substrates.
 - 1. Basis of Design: Subject to compliance with requirements, provide W.R. Meadows, Inc. AIR-SHIELD LSR, or a comparable product by one of the following:
 - a. Tremco, Exo Air 130.
 - b. GCP Applied Technologies Inc. (formerly Grace Construction Products), Perm-a-barrier NPL 10.
 - 2. Physical and Performance Properties:
 - a. Air Permeance: Maximum 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. (0.02 L/s x sq. m of surface area at 75-Pa) pressure difference; ASTM E 2178.
 - b. Water Vapor Permeance, per ASTM E96 (Method A): ≤ 0.1 perms.
 - c. Elongation at Break, per ASTM D412: 700%
 - d. Tensile Strength, per ASTM D412: 250 psi.
 - e. Nail Sealability, per ASTM D1970: Pass.
 - f. UV Resistance: Can be exposed to sunlight for indicated number of days according to manufacturer's written instructions.

2.4 ACCESSORY MATERIALS

- A. Requirement: Provide primers, transition strips, termination strips, joint reinforcing fabric and strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by air-barrier manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.
- B. Flashing and Transition Membrane: Self-adhesive polymeric, flexible air and vapor membrane having a thickness of 40 mils (1 mm). Provide AIR-SHIELD THRU-WALL FLASHING or comparable product by one of the following:
 - 1. Tremco.
 - 2. GCP Applied Technologies, Inc.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

- A. Clean, prepare, treat, fill, and seal substrate and joints and cracks in substrate according to manufacturer's written instructions and details. Provide clean, dust-free, and dry substrate for air-barrier application.
- B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.
- C. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching material.
- D. Remove excess mortar from masonry ties, shelf angles, and other obstructions.
- E. 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.
- F. Bridge isolation joints, expansion joints, and discontinuous wall-to-wall, deck-to-wall, and deck-to-deck joints with air-barrier accessory material that accommodates joint movement according to manufacturer's written instructions and details.

3.2 INSTALLATION

- A. Install materials according to air-barrier manufacturer's written instructions and details to form a seal with adjacent construction and ensure continuity of air and water barrier.
 - 1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
 - 2. Install transition strip on roofing membrane or base flashing so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate.

3. Unless manufacturer recommends in writing against priming, apply primer to substrates at required rate and allow it to dry.
 4. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by air-barrier material on same day. Reprime areas exposed for more than 24 hours.
- B. Connect and seal exterior wall air-barrier material continuously to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
 - C. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition strip so that a minimum of 3 inches (75 mm) of coverage is achieved over each substrate. Maintain 3 inches (75 mm) of full contact over firm bearing to perimeter frames, with not less than 1 inch (25 mm) of full contact.
 - D. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches (150 mm) beyond repaired areas in strip direction.
 - E. Do not cover air barrier until it has been tested and inspected by testing agency.
 - F. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.3 CLEANING AND PROTECTION

- A. Protect air-barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.
- B. Remove masking materials after installation.

END OF SECTION 072726

SECTION 073113
ASPHALT SHINGLES

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:

- 1. Asphalt shingles.
- 2. Leak barrier and roof deck protection.
- 3. Ridge vents.
- 4. Metal flashing and trim.

B. Related Sections:

- 1. Section 074113.16 "Standing Seam Metal Roof Panels".
- 2. Section 076200 “Sheet Metal Flashing and Trim”.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified.
- C. Shop Drawings: Include installation layouts; details of edge conditions, ridges and valleys, anchorages, trim, flashings, closures, and accessories; and special details.

1.5 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Evaluation reports.

- C. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer for installation of all roofing products installed under this section.
- B. Source Limitations: Provide all primary roofing products, including shingles, underlayment, leak barrier, and ventilation, by a single manufacturer.

1.8 PREINSTALLATION MEETING

- A. General: For all projects in excess of 250 squares of roofing, a pre-installation meeting is strongly recommended.
- B. Timing: The meeting shall take place at the start of the roofing installation, no more than 2 weeks into the roofing project.
- C. Attendees: Meeting to be called for by manufacturer's certified contractor. Meeting's mandatory attendees shall include the certified contractor and the manufacturer's representative. Non-mandatory attendees shall include the Client Agency's representative, Design Professional, and the general contractor's representative.
- D. Topics: Certified contractor and manufacturer's representative shall review all pertinent requirements for the project, including but not limited to, scheduling, weather considerations, project duration, and requirements for the specified warranty.

1.9 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace asphalt shingles that fail within specified warranty period.
 - 1. Material Warranty Period: 40 years from date of Final Acceptance, prorated, with first 20 years non-prorated.
 - 2. Wind-Speed Warranty Period: Asphalt shingles will resist blow-off or damage caused by wind speeds of up to 110 mph (49 m/s) for 15 years from date of Final Acceptance.
 - 3. Algae-Resistance Warranty Period: Asphalt shingles will not discolor for 10 years from date of Final Acceptance.
 - 4. Workmanship Warranty Period: Two years from date of Final Acceptance.
- B. Warranty terms are applicable to asphalt shingles installed directly on Structural Insulated Panels in a "hot" roof application.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Exterior Fire-Test Exposure: Provide asphalt shingles and related roofing materials identical to those of assemblies tested for Class A fire resistance according to ASTM E 108 or UL 790 by Underwriters Laboratories, Inc. or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.

2.2 GLASS-FIBER-REINFORCED ASPHALT SHINGLES

- A. Laminated-Strip Asphalt Shingles: ASTM D 3462/D 3462M, laminated, multi-ply overlay construction, glass-fiber reinforced, mineral-granule surfaced, and self-sealing.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide GAF Materials Corporation; Timberline Cool Series Energy-Saving Architectural Shingles or a comparable product by one of the following:
 - a. CertainTeed Corporation.
 - b. Owens Corning.
 - 2. Appearance: Wood shake.
 - 3. Exposure: 5-5/8"
 - 4. Strip Size: Manufacturer's standard.
 - 5. Algae Resistance: Granules resist algae discoloration.
 - 6. Impact Resistance: UL 2218, Class 4.
 - 7. Solar Reflectance Index: 29.
 - 8. Color and Blends: To be selected by Professional from Manufacturer's full range of standard colors.
- B. Hip and Ridge Shingles: Manufacturer's standard units to match asphalt shingles.

2.3 ROOF DECK PROTECTION AND LEAK BARRIER MATERIALS

- A. Synthetic Underlayment: UV-resistant polypropylene, polyolefin, or polyethylene polymer fabric with surface coatings or treatments to improve traction underfoot and abrasion resistance; evaluated and documented to be suitable for use as a roof underlayment under applicable codes by a testing and inspecting agency acceptable to authorities having jurisdiction.
 - 1. Manufacturer's standard product as recommended for specified installation.
- B. Self-Adhering Sheet Underlayment, High Temperature: Minimum of 40-mil- (1.0-mm-) thick; with slip-resisting, polymer-film-reinforced or glass-reinforced top surface laminated to layer of butyl or SBS-modified asphalt adhesive; with release backing; cold applied; and evaluated and documented to be suitable for use for intended purpose under applicable codes by a testing and

inspecting agency acceptable to authorities having jurisdiction. Provide primer for adjoining concrete or masonry surfaces to receive underlayment.

1. Manufacturer's standard product as recommended for specified installation.
2. Thermal Stability: Stable after testing at 240 deg F (116 deg C) according to ASTM D 1970/D 1970M.
3. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C) according to ASTM D 1970/D 1970M.

2.4 RIDGE VENTS

- A. Rigid Ridge Vent: Manufacturer's standard, rigid section high-density polypropylene or other UV-stabilized plastic ridge vent for use under ridge shingles.
 1. Minimum Net Free Area: 18.0.
 2. Features:
 - a. Nonwoven geotextile filter strips.
 - b. External deflector baffles.

2.5 ACCESSORIES

- A. Asphalt Roofing Cement: ASTM D 4586, Type II, asbestos free.
- B. Roofing Nails: ASTM F 1667; aluminum, stainless-steel, copper, or hot-dip galvanized-steel wire shingle nails, minimum 0.120-inch- (3-mm-) diameter, sharp-pointed, with a minimum 3/8-inch- (9.5-mm-) diameter flat head and of sufficient length to penetrate 3/4 inch (19 mm) into solid wood decking or extend at least 1/8 inch (3 mm) through OSB or plywood sheathing.
 1. Shank: Barbed, Smooth or Deformed-shank, as recommended by shingle manufacturer.
 2. Where nails are in contact with metal flashing, use nails made from same metal as flashing.
- C. Felt-Underlayment Nails: Aluminum, stainless-steel, or hot-dip galvanized-steel wire with low-profile capped heads or disc caps, 1-inch (25-mm) minimum diameter.
- D. Synthetic-Underlayment Fasteners: As recommended in writing by synthetic-underlayment manufacturer for application indicated.

2.6 METAL FLASHING AND TRIM

- A. General: Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."
- B. Fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of the item.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Where indicated on the Drawings, remove all existing roofing down to the roof deck. Verify that the deck is structurally sound and free of deteriorating decking. Replace damaged deck with new materials.
- B. Verify that the deck is dry, sound, clean and smooth. It shall be free of any depressions, waves, and projections. Cover with sheet metal, all holes over 1 inch in diameter, cracks over 1/2 inch in width, loose knots and excessively loose resinous areas.
- C. Clean deck surfaces thoroughly prior to installation of eaves protection membrane and underlayment.
- D. At areas receiving eaves protection membranes, fill knotholes and cracks with latex filler.

3.2 UNDERLAYMENT INSTALLATION

- A. General: Comply with underlayment manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.
- B. Synthetic Underlayment: Install on roof deck parallel with and starting at the eaves. Lap sides and ends and treat laps as recommended in writing by manufacturer. Stagger end laps between succeeding courses at interval recommended in writing by manufacturer. Fasten according to manufacturer's written instructions. Cover underlayment within period recommended in writing by manufacturer.
 - 1. Install in single layer on roofs sloped at 4:12 and greater.
 - 2. Install in double layer on roofs sloped at less than 4:12.
- C. Self-Adhering Sheet Underlayment: Install, wrinkle free, on roof deck. Comply with low-temperature installation restrictions of underlayment manufacturer if applicable. Install lapped in direction that sheds water. Lap sides not less than 3-1/2 inches (89 mm). Lap ends not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Roll laps with roller. Cover underlayment within seven days.
 - 1. Prime concrete and masonry surfaces to receive self-adhering sheet underlayment.

3.3 METAL FLASHING INSTALLATION

- A. General: Install metal flashings and other sheet metal to comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."
 - 1. Install metal flashings according to recommendations in ARMA's "Residential Asphalt Roofing Manual" and NRCA's "NRCA Guidelines for Asphalt Shingle Roof Systems."

3.4 ASPHALT-SHINGLE INSTALLATION

- A. General: Install asphalt shingles according to manufacturer's written instructions, recommendations in ARMA's "Residential Asphalt Roofing Manual," and recommendations in NRCA's "NRCA Guidelines for Asphalt Shingle Roof Systems."
- B. Install manufacturer's standard starter strip along lowest roof edge with self-sealing strip face up at roof edge.
 - 1. Extend asphalt shingles 1/2 inch (13 mm) over fasciae at eaves and rakes.
 - 2. Install starter strip along rake edge.
- C. Install first and remaining courses of asphalt shingles stair-stepping diagonally across roof deck with manufacturer's recommended offset pattern at succeeding courses, maintaining uniform exposure.
- D. Install first and remaining courses of asphalt shingles stair-stepping diagonally across roof deck with manufacturer's recommended offset pattern at succeeding courses, maintaining uniform exposure.
- E. Install asphalt shingles by single-strip column or racking method, maintaining uniform exposure. Install full-length first course followed by cut second course, repeating alternating pattern in succeeding courses.
- F. Fasten asphalt-shingle strips with a minimum of four roofing nails located according to manufacturer's written instructions.
 - 1. Where roof slope is less than 4:12, seal asphalt shingles with asphalt roofing cement spots.
 - 2. When ambient temperature during installation is below 50 deg F (10 deg C), seal asphalt shingles with asphalt roofing cement spots.
- G. Open Valleys: Cut and fit asphalt shingles at open valleys, trimming upper concealed corners of shingle strips. Maintain uniform width of exposed open valley from highest to lowest point.
 - 1. Set valley edge of asphalt shingles in a 3-inch- (75-mm-) wide bed of asphalt roofing cement.
 - 2. Do not nail asphalt shingles to metal open-valley flashings.
- H. Ridge Vents: Install continuous ridge vents over asphalt shingles in locations indicated on the Drawings according to manufacturer's written instructions. Fasten with roofing nails of sufficient length to penetrate sheathing.
- I. Hip and Ridge Shingles: Maintain same exposure of cap shingles as roofing shingle exposure. Lap cap shingles at ridges to shed water away from direction of prevailing winds. Fasten with roofing nails of sufficient length to penetrate sheathing.
 - 1. Fasten ridge cap asphalt shingles to cover ridge vent without obstructing airflow.

END OF SECTION 073113

SECTION 074113.16

STANDING-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Standing-seam metal roof panels including all flashings, copings, and trim associated with standing-seam roof panels.
 - 2. Underlayment.
- B. Related Sections:
 - 1. Section 061600 “Sheathing.”
 - 2. Section 077100 “Roof Specialties.”

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: 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.
- C. Samples: For each type of metal panel indicated.

1.5 INFORMATIONAL SUBMITTALS

- A. Product test reports.
- B. Warranties: Sample of special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.7 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 the projects of similar size and complexity.
- B. **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.
- C. **UL-Certified, Portable Roll-Forming Equipment:** UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.
- D. **Mock-ups:** Build mock-ups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrications and installation.
 - 1. Build mock-up of typical roof eave as shown on Drawings; approximately four panels wide by full eave width, including entire roof assembly. Provide mock-up in final colors and finishes.
 - 2. Approval of mock-up does not constitute approval of deviations from the Contract Documents contained in mock-up unless the Professional specifically approves such deviation in writing.
 - 3. Approved mock-up may become part of the completed Work.

1.8 WARRANTY

- A. **Contractors' 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 Client Agency, 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 judgement of the Client Agency, 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 Client Agency 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 Client Agency 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 Client Agency may undertake corrective measures. The Contractor shall be responsible for any and all expenses incurred by the Client Agency in undertaking the necessary corrective measures. In addition, the Client Agency's undertaking of corrective measures shall in no way relieve the Contractor of any of the aforementioned responsibilities.

B. Manufacturer's Warranty:

1. The General Contractor shall provide the Client Agency with a twenty (20) year warranty, furnished by the manufacturer, which shall warrant that the said manufacturer will repair any leaks in the roofing system, not to exceed the original cost of the installed roof over the life of the warranty, installed by an applicator authorized by said manufacturer.
2. Leaks from the following causes shall be covered by the manufacturer's warranty:
 - a. Defects in the roofing system material.
 - b. Workmanship of the authorized applicator.
3. The following exclusions are permitted in the manufacturer's warranty:
 - a. Natural disasters such as lightning, hail, floods, tornadoes, or earthquakes.
 - b. Damage from traffic or storage of materials on the roof.
 - c. Structural failure of roof deck, parapet, or coping.
 - d. Infiltration of moisture in, through or around walls, coping or building structure.
 - e. Movement or deterioration of metal counterflashing or other metal components adjacent to the roof.
 - f. Damage to the building (other than roofing and insulation) or its components adjacent to the roof.
4. The warranty shall provide that in the event a leak should occur within the warranty period, and if such leak is within the coverage of the warranty, the warrantor will, at no expense to the Client Agency, make or have made, all necessary repairs to put the roof membrane, base flashing, and roof insulation in a dry and watertight condition, using the same materials and specifications as the original application. There will be no limit to the warrantor's liability for making such repairs over the period of the warranty.
5. The warranty shall provide that if, upon proper notification, the warrantor fails to promptly repair the roof, and the Client Agency may make temporary repairs to avoid damage to the facility. Such an action shall not be considered a breach of the provisions of the warranty.
6. The Client Agency shall be permitted to make alterations, additions and repairs to the roof, within the written approved guidelines of the warrantor without jeopardizing the unexpired portion of the warranty's original term.
7. Metal roofs and exposed fasteners shall be warranted against rust. Also, on metal roofs, the manufacturer, upon substantial completion, inspection and written acceptance of the roof installation, shall furnish a warranty to repair finish or replace metal panels and materials that show evidence of deterioration of factory-applied finishes; including but not limited to cracking, checking, blistering, peeling, flaking and chipping for a period of twenty (20) years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Energy Performance: Provide roof panels according to one of the following when tested according to CRRC-1:
 - 1. Three-year, aged solar reflectance of not less than 0.57 when tested in accordance with ASTM E 1918.
- C. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:
 - 1. Wind Loads: As indicated on Drawings.
 - 2. Other Design Loads: As indicated on Drawings.
 - 3. Deflection Limits: For wind loads, no greater than 1/180 of the span.
- D. Air Infiltration: Air leakage of not more than 0.09 cfm/sq. ft. (0.457 L/s per sq. m) when tested according to ASTM E1680 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).
- E. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E1646 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 12 lbf/sq. ft. (575 Pa).
- F. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E2140.
- G. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
 - 1. Uplift Rating: UL 90.
- H. 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 (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 STANDING-SEAM METAL ROOF PANELS

- A. Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.

1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1514.
- B. Vertical-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels : Formed with vertical ribs at panel edges and a flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and mechanically seaming panels together.
1. Basis of Design Product: Subject to compliance with requirements, provide; Englert, Inc.; S2000, standing seam roof system or comparable product by one of the following:
 - a. MBCI , SuperLok
 - b. Merchant & Evans, Inc.; 2” ZIP LOK
 - c. Pac-Clad, Snap-Clad
 2. Aluminum Sheet: Coil-coated sheet, ASTM B209 (ASTM B209M), alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.
 - a. Nominal Thickness: 0.040 inch (1.02 mm).
 - b. Exterior Finish: Two-coat fluoropolymer
 - c. Color: Englert Hartford Green.
 - d. Panel Coverage: 18 inches (457 mm).
- C. Panel Clips: Provide panel clip of type specified, at spacing indicated on approved shop drawings.
1. Two-piece Floating: ASTM C 645, with ASTM A 653/A 653M, G90 (Z180) hot-dip galvanized zinc coating, configured for concealment in panel joints, and identical to clips utilized in tests demonstrating compliance with performance requirements.
 2. Single-Piece Fixed: ASTM C 645, with ASTM A 653/A 653M, G90 (Z180) hot-dip galvanized zinc coating, configured for concealment in panel joints, and identical to clips utilized in tests demonstrating compliance with performance requirements.
- D. Panel Fasteners: Self-tapping screws and other acceptable fasteners recommended by roof panel manufacturer. Where exposed fasteners cannot be avoided, supply long life fasteners with EPDM or neoprene gaskets, with heads matching color of metal panels by means of factory-applied coating.
- E. Joint Sealers: Manufacturer's standard or recommended liquid and preformed sealers and tapes, and as follows:
1. Factory-Applied Seam Sealant: Manufacturer's standard hot-melt type.
 2. Tape Sealers: Manufacturer's standard non-curing butyl tape, AAMA 809.2.
 3. Joint Type: Mechanically seamed.
 4. Panel Coverage: 18 inches (457 mm).
 5. Panel Surface: Smooth, flat.
 6. Panel Height: 1.75 inches (44.5 mm).

2.3 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 40 mils (1.02 mm) thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.
1. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D1970.
 2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D1970.
 3. Products: Subject to compliance with requirements, provide one of the following:
 - a. GCP Applied Technologies; Grace Ice & Water Shield HT or Ultra.
 - b. Henry Company; Blueskin PE200 HT.
 - c. MFM Building Products Corp.; Ultra HT Wind & Water Seal.
 - d. Metal roofing manufacturer's high temperature roofing underlayment.
- B. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

2.4 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C645; cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 (Z275 hot-dip galvanized) coating designation or ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- C. 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, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Gutters and Downspouts: Formed from same material as roof panels according to SMACNA's "Architectural Sheet Metal Manual." Finish to be selected by the Professional.
- E. Roof Curbs: Fabricated from same material as roof panels, 0.048-inch (1.2-mm) nominal thickness; with bottom of skirt profiled to match roof panel profiles and with welded top box and integral full-length cricket. Fabricate curb subframing of 0.060-inch- (1.52-mm-) nominal

thickness, angle-, C-, or Z-shaped steel sheet. Fabricate curb and subframing to withstand indicated loads of size and height indicated. Finish roof curbs to match metal roof panels.

- F. Panel Fasteners: Self-tapping screws designed to withstand design loads.
- G. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
 - 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing; 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
 - 2. Joint Sealant: ASTM C920; as recommended in writing by metal panel manufacturer.
 - 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.5 FABRICATION

- A. 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.

2.6 FINISHES

- A. Panels and Accessories:
 - 1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat.
 - 2. Concealed Interior Finish: 0.5 mil total dry film thickness consisting of primer coat and wash coat of manufacturer's standard light-colored acrylic or polyester backer finish.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.
- B. Flashings: Install flashings to cover exposed underlayment.

3.2 INSTALLATION OF UNDERLAYMENT

- A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated on Drawings, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches (152 mm) staggered 24 inches (610 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Extend underlayment into gutter trough. Roll laps with roller. Cover underlayment within 14 days.
 - 1. Apply over the entire roof surface.
 - 2. Apply over the roof area indicated below:
 - a. Roof perimeter for a distance up from eaves of 36 inches (914 mm) beyond interior wall line.
 - b. Valleys, from lowest point to highest point, for a distance on each side of 18 inches (460 mm). Overlap ends of sheets not less than 6 inches (152 mm).
 - c. Rake edges for a distance of 18 inches (460 mm).
 - d. Hips and ridges for a distance on each side of 12 inches (305 mm).
 - e. Roof-to-wall intersections for a distance from wall of 18 inches (460 mm).
 - f. Around dormers, chimneys, skylights, and other penetrating elements for a distance from element of 18 inches (460 mm).
- B. Slip Sheet: Apply slip sheet over underlayment before installing metal roof panels.

3.3 INSTALLATION OF STANDING SEAM METAL ROOF PANELS

- A. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
 - 1. Install clips to supports with self-tapping fasteners.
 - 2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
 - 3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
 - 4. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
 - 5. Watertight Installation:

- a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
 - b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
 - c. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with sealant and fastened together by interlocking clamping plates.
- B. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
- C. 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 will be permanently watertight and weather resistant.

3.4 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.

END OF SECTION 074113.16

SECTION 074610

INTERIOR VINYL WALL AND CEILING PANELS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Vinyl soffit and vertical siding panels used as interior wall and ceiling panels.
- B. Related Sections:
 - 1. Section 06100 “Rough Carpentry” for exterior sheathing for backing for vinyl panels.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: Full-size units of each type of panel type and trim in each color, texture, and pattern required.

1.4 INFORMATIONAL SUBMITTALS

- A. Product test reports.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Manufacturers: Subject to compliance with requirements, provide products by CertainTeed Corporation, Valley Forge, PA (800) 233-8990 or a comparable product by one of the following:
 - 1. Owens Corning.
 - 2. Gentek Building Products, Inc.

2.2 INTERIOR SOFFIT PANELS

- A. Vinyl Soffit and Vertical Siding: Basis of Design shall be CertainTeed Ironmax Vinyl Soffit made of custom formulated PVC resin in compliance with ASTM D 3679 and D4477.
 - 1. Style: Double 5-inch solid panels.
 - 2. Thickness: .046 inch.
 - 3. Panel Projection: 9/16".
 - 4. Lock Design: Post-formed.
 - 5. Texture: As selected by the Professional from manufacturer's full range.
 - 6. Color and Texture: As selected by the Professional from manufacturer's full range.

2.3 TRIM ACCESSORIES

- A. Accessories: Provide all necessary coordinating trim accessories such as trim, corner systems and decorative moldings and other items in profiles as indicated on the drawings and if not indicated provide all necessary trim work as recommended by the soffit manufacturer for a complete watertight configuration.
 - 1. Provide accessories made from same color and material as soffit and fascia, unless otherwise indicated.
- B. Fasteners: Use aluminum fasteners.
 - 1. Where fasteners will be exposed to view, use prefinished aluminum fasteners in color to match item being fastened.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Coordinate installation of other adjoining construction to ensure proper sequencing.
- B. Comply with vinyl panel manufacturer's written installation instructions unless more stringent requirements apply.

- C. Install vinyl panels and accessories according to manufacturer's instructions.
- D. Install vinyl panels on a solid backing of ½" exterior sheathing board.

END OF SECTION 074610

SECTION 074646
FIBER-CEMENT SIDING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section includes fiber-cement siding, soffit, ceiling, and foundation wall skirting.
- B. Related Sections:
 - 1. Section 099113 “Painting.”

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Samples: For fiber-cement siding and soffit including related accessories.
- C. Color Samples: For protective acrylic coating.

1.4 INFORMATIONAL SUBMITTALS

- A. Product certificates.
- B. Product test reports.
- C. Research/evaluation reports.
- D. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing Work of this section as approved by manufacturer.
- B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and to set quality standards for fabrication and installation.
 - 1. Build mockup of typical wall area as shown on Drawings.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace products that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 30 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FIBER-CEMENT LAP SIDING

- A. Source Limitations: Obtain products, including related accessories, from single source from single manufacturer.
- B. General: ASTM C1186, Type A, Grade II, fiber-cement board, noncombustible when tested according to ASTM E136; with a flame-spread index of 25 or less when tested according to ASTM E84.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide James Hardie Building Products Inc.; Artisan Lap Siding or comparable product by one of the following:
 - a. Nichiha Architectural Panels, Savannah Smooth plank siding.
- C. Labeling: Provide fiber-cement siding that is tested and labeled according to ASTM C1186 by a qualified testing agency acceptable to authorities having jurisdiction.
- D. Nominal Thickness: Not less than 5/8 inch (16 mm).
- E. Width: Boards 8 1/4" (260mm) wide.
- F. Exposure: 7"
- G. Texture: Smooth
- H. Profile: Lap

- I. Length: Minimum 12 ft (3.66 m)
- J. Factory Priming: Manufacturer's standard acrylic primer.
- K. Corners: Mitered

2.2 FIBER-CEMENT SOFFIT

- A. General: ASTM C1186, Type A, Grade II, fiber-cement board, noncombustible when tested according to ASTM E136; with a flame-spread index of 25 or less when tested according to ASTM E84.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide James Hardie Building Products Inc.; Hardiesoffit Panels, Non-Vented Smooth or comparable product by one of the following:
 - a. Nichiha Architectural Panels, Nichisoffit.
- B. Nominal Thickness: Not less than 1/4 inch (8 mm).
- C. Pattern: Width of sheet based on drawings, smooth texture.
- D. Factory Priming: Manufacturer's standard acrylic primer.

2.3 FIBER-CEMENT CEILING

- A. General: ASTM C1186, Type A, Grade II, fiber-cement board, noncombustible when tested according to ASTM E136; with a flame-spread index of 25 or less when tested according to ASTM E84.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide James Hardie Building Products Inc.; Hardiesoffit Beaded Porch Panel or comparable product by one of the following:
 - a. Nichiha Architectural Panels.
- B. Nominal Thickness: Not less than 1/4 inch (8 mm).
- C. Pattern: 48 inch wide panel, beaded.
- D. Factory Priming: Manufacturer's standard acrylic primer.

2.4 FIBER CEMENT TRIM AND BATTEN BOARDS

- A. Trim:
 - 1. HardieTrim 4/4 NT3 boards as manufactured by James Hardie Building Products, Inc. or approved equal.
 - 2. HardieTrim HZ5 Fascia boards as manufactured by James Hardie Building Products, Inc. or approved equal.

3. Width: As indicated on Drawings.
- B. Batten Boards
 1. Width: Manufacturer's standard.
- C. Nominal Thickness: Not less than 3/4 inch.
- D. Panel Texture: smooth texture.
- E. Factory Priming: Manufacturer's standard acrylic primer.

2.5 FIBER-CEMENT SKIRTING BOARD

- A. General: Fiber cement backer board panels for exterior installation at base of foundation wall.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide James Hardie Building Products Inc.; Hardiebacker 500.
- B. Nominal Thickness: 1/2 inch (13 mm) nominal thickness.
- C. Size: 36 inch wide panel.
- D. Material shall meet the following requirements:
 1. Compressive Strength: 6,500 psi per ASTM D2394
 2. Flexural Strength: 1,700 psi per ASTM C947
 3. Freeze/Thaw Resistance: pass per ASTM C6666 (Procedure B) Type A
 4. Noncombustibility: pass per ASTM E136
 5. Flame Spread/Smoke Developed Index: 0 to 5 or less per ASTM E84
 6. Waterproofness: pass per ANSI A118.10
 7. Fasteners: Corrosion-resistant ribbed wafer head screws per manufacturer's requirements.
- E. Protective Acrylic Coating
 1. Premixed protective coating for areas of exposed fiber cement backerboard over rigid insulation.
 - a. Basis-of-Design Product: Tuff II Foundation Insulation and ICF Coating by Styro Industries. www.styro.net.
 - b. Provide manufacturer's standard prep layer at seams and corners: Sticky Mesh HD.
 - c. Composition: Polymer based 100% acrylic, pH (wet) 10.5, Density (wet) 12 lbs per gallon.
 - d. Applications: Two Coats.
 - e. Finish: Orange Peel.
 - f. Color: from manufacturer's standard range.

2.6 ACCESSORIES

- A. Siding Accessories, General: Provide starter strips, edge trim, and other items as recommended by siding manufacturer for building configuration.
 - 1. Provide accessories matching color and texture of adjacent siding unless otherwise indicated.
- B. Attachment: Basis-of-Design Product: Subject to compliance with requirements, provide Knightwall S-Series MFI or Equal Thermally Broken System as approved by the Professional.
- C. Flashing: Provide flashing complying with Section 076200 "Sheet Metal Flashing and Trim" at window and door heads and where indicated.
- D. Fasteners:
 - 1. For fastening to wood, use siding nails or ribbed bugle-head screws of sufficient length to penetrate a minimum of 1 inch (25 mm) into substrate.
 - 2. For fastening to metal, use ribbed bugle-head screws of sufficient length to penetrate a minimum of 1/4 inch (6 mm), or three screw-threads, into substrate.
 - 3. For fastening fiber cement, use stainless steel fasteners.
- E. Insect Screening for Rainscreen Cavities: 26 ga. Aluminum, L- or U-shaped, 1/4 in x 1/4 in mesh.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.
 - 1. Do not install damaged components.
- B. Install joint sealants as specified in Section 079200 "Joint Sealants" and to produce a weathertight installation.
- C. Install fiber cement siding level, plumb, true, and aligned with adjacent materials.
 - 1. Install fasteners no more than 24 inches (600 mm) o.c.
 - 2. Use concealed shims where necessary for alignment.
 - 3. Scribe and cut exterior finish carpentry to fit adjoining work.
 - 4. Refinish and seal cuts as recommended by manufacturer.
 - 5. Install to tolerance of 1/8 inch in 96 inches (3 mm in 2438 mm) for level and plumb. Install adjoining exterior finish carpentry with 1/32-inch (0.8-mm) maximum offset for flush installation and 1/16-inch (1.5-mm) maximum offset for reveal installation.
 - 6. Leave gap at perimeter, openings, and horizontal joints as recommended by manufacturer.
 - 7. Seal butt joints at inside and outside corners and at trim locations.
 - 8. Coordinate exterior finish carpentry with materials and systems in or adjacent to it.

9. Provide cutouts for mechanical and electrical items that penetrate exterior finish carpentry and finish as recommended by manufacturer of siding.
10. Conceal fasteners to greatest practical extent by placing in grooves of siding pattern or as recommended by manufacturer.
11. Miter outside and inside corners.

D. Install fiber-cement trim.

1. Fasten through trim into structural framing or code complying sheathing. Fasteners must penetrate minimum 3/4 inch or full thickness of sheathing. Additional fasteners may be required to ensure adequate security.
2. Place fasteners no closer than 3/4 inch and no further than 2 inches from side edge of trim board and no closer than 1 inch from end. Fasten maximum 16 inches on center.
3. Maintain clearance between trim and adjacent finished grade.
4. Trim inside corner with a single board. Trim both sides of corner.
5. Outside Corner Board: Attach Trim on both sides of corner with 16 gage corrosion resistant finish nail 1/2 inch from edge spaced 16 inches apart, weather cut each end spaced minimum 12 inches apart.
6. Allow 1/8 inch gap between trim and siding.
7. Seal gap with high quality, paint-able caulk.
8. Shim frieze board as required to align with corner trim..
9. Fasten through overlapping boards. Do not nail between lap joints.
10. Overlay siding with single board of outside corner board then align second corner board to outside edge of first corner board. Do not fasten trim boards to trim boards.
11. Shim frieze board as required to align with corner trim.
12. Install fascia boards to rafter tails or to sub fascia.

E. Finishing:

1. Finish factory primed siding with a minimum of one coat of high quality 100 percent acrylic exterior flat grade paint with flat finish within 180 days of installation. Follow paint manufacturer's written product requirements and written application instructions.
2. Field cut edges shall be coated during the installation process using an exterior grade primer/sealer that is compatible with the type of paint to used on project.

3.2 INSTALLATION, FIBER CEMENT SKIRTING BOARD

- A. Install in accordance with manufacturer's instructions. Install sheets with 1/8 inch (3 mm) gap between sheets.
- B. Place fasteners 8 inches (152 mm) on center no closer than 3/8 inch (9.5 mm) from board edges and 2 inches (51 mm) from board corners.
- C. Completely coat exposed faces and edges of panels with protective acrylic coating, applied per coating manufacturer's recommendations.

3.3 ADJUSTING AND CLEANING

- A. Remove damaged, improperly installed, or otherwise defective materials and replace with new materials complying with specified requirements.

- B. Clean finished surfaces according to manufacturer's written instructions and maintain in a clean condition during construction.

END OF SECTION 074646

SECTION 077100
ROOF SPECIALTIES

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Roof-edge drainage systems and downspouts
 - 2. Snow guards.
- B. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
- C. Shop Drawings: For roof specialties.
 - 1. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work.
- D. Samples: For each type of roof specialty and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For tests performed by a qualified testing agency.
- B. Sample warranty.

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.

1.7 WARRANTY

- A. 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 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, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 30 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. FM Approvals' Listing: Manufacture and install roof-edge specialties that are listed in FM Approvals' "RoofNav" and approved for windstorm classification. Identify materials with FM Approvals' markings.
- C. SPRI Wind Design Standard: Manufacture and install roof-edge specialties tested according to SPRI ES-1 and capable of resisting the following design pressures:
 - 1. Design Pressure: As indicated on Drawings.
- D. 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 (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- E. Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 ROOF-EDGE DRAINAGE SYSTEMS

- A. Gutters: Manufactured in uniform section lengths not exceeding 12 feet (3.6 m), with matching corner units, ends, outlet tubes, and other accessories. 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. Aluminum Sheet: 0.040 inch (1.02 mm) thick.
 2. Gutter Profile: 5 inch half round highback according to SMACNA's "Architectural Sheet Metal Manual."
 3. Corners: Factory mitered and mechanically clinched and sealed watertight.
 4. Gutter Supports: Manufacturer's standard supports as selected by Architect with finish matching the gutters.
 5. Accessories: Continuous, removable leaf screen with sheet metal frame and hardware cloth screen.
- B. Downspouts: Plain round, 4" diameter. Formed from same material as roof panels. Fabricate in 10-foot- (3-m-) long sections, complete with formed elbows and offsets, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual".
- C. Aluminum Finish: Two-coat fluoropolymer AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat.
- D. Color: As selected by Architect from manufacturer's full range, to coordinate with metal roof panels.

2.3 SNOW GUARDS

- A. Seam-Mounted, Standing Seam Snow Guards: Aluminum flat strip style panels held in place by stainless steel clamps attached to vertical ribs or standing seam metal roof panels intended to prevent snow from sliding under guard.
 1. Manufacturers: Provide S-5! ColorGard
<https://s-5.com/products/colorgard/>
 2. Material: Aluminum.
 3. Finish: Mill.
 4. Insert Color: To match roofing- Englert's Hartford Green.

2.4 MATERIALS

- A. Aluminum Sheet: ASTM B209 (ASTM B209M), alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.

2.5 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 Aluminum: Aluminum or Series 300 stainless steel.
- B. Elastomeric Sealant: ASTM C920, elastomeric polyurethane polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.
- C. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- D. Asphalt Roofing Cement: ASTM D4586, asbestos free, of consistency required for application.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. 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.
 - 5. Do not use graphite pencils to mark metal surfaces.
- 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. 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 (3.6 m) with no joints within 18 inches (450 mm) of corners or intersections unless otherwise indicated on Drawings.
 - 2. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), 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 (32 mm) for nails and not less than 3/4 inch (19 mm) 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 (4 deg C).

3.2 INSTALLATION OF ROOF-EDGE DRAINAGE-SYSTEM

- A. Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.
- B. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than 30 inches (762 mm) apart. Attach ends with rivets and seal with sealant to make watertight. Slope to downspouts.
 - 1. Install gutter with expansion joints at locations indicated but not exceeding 50 feet (15.2 m) apart. Install expansion-joint caps.
 - 2. Install continuous leaf guards on gutters with noncorrosive fasteners, removable for cleaning gutters.
- C. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1500 mm) o.c.
 - 1. Provide elbows at base of downspouts at grade to direct water away from building.
 - 2. Connect downspouts to underground drainage system indicated.

3.3 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Remove temporary protective coverings and strippable films as roof specialties are installed.

END OF SECTION 077100

SECTION 078413

PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Penetration firestopping systems for the following applications:
 - a. Penetrations in fire-resistance-rated walls.
 - b. Penetrations in horizontal assemblies.
 - c. Penetrations in smoke barriers.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product, including VOC content.
- B. Through-Penetration Firestop System Schedule: Indicate locations of each penetration firestop system, along with the following information:
 - 1. Types of penetrating items.
 - 2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.
 - 3. Penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.

1.5 INFORMATIONAL SUBMITTALS

- A. Product test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Approval according to FM Approval 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
 - 1. Fire-resistance-rated walls including fire walls, fire partitions, fire barriers and smoke barriers.
 - 2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies and ceiling membranes of roof/ceiling assemblies.
- B. Rated Systems: Provide penetration firestop systems with the following ratings determined per ASTM E 814:
 - 1. F-Rated Systems: Provide penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
 - 2. T-Rated Systems: For the following conditions, provide penetration firestop systems with T-ratings indicated, as well as F-ratings, where systems protect penetrating items exposed to potential contact with adjacent materials in occupied floor areas:
 - a. Penetrations located outside wall cavities.
 - 3. L-Rated Systems: Where penetration firestop systems are indicated in smoke barriers, provide penetration firestop systems with L-ratings of not more than 3.0 cfm/sq. ft (0.01524cu. m/s x sq. m) at both ambient temperatures and 400 deg F (204 deg C).
- C. For penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
 - 1. For piping penetrations for plumbing, provide moisture-resistant penetration firestop systems.

2. For floor penetrations with annular spaces exceeding 4 inches (100 mm) in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved, either by installing floor plates or by other means.
 3. For penetrations involving insulated piping, provide penetration firestop systems not requiring removal of insulation.
- D. For penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- E. Fire-Test-Response Characteristics:
1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
 2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:
 - a. Penetration firestop system products bear classification marking of qualified testing and inspecting agency.
 - b. Penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the following:
 - 1) UL in its "Fire Resistance Directory."

2.2 PENETRATION FIRESTOPPING SYSTEMS

- A. Penetration Firestopping Systems: Systems that resist spread of fire, 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. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers:
1. A/D Fire Protection Systems Inc.
 2. Grace, W. R. & Co. - Conn.
 3. Hilti, Inc.
 4. Johns Manville.
 5. Nelson Firestop Products.
 6. 3M; Fire Protection Products Division.
 7. Tremco; Sealant/Weatherproofing Division.
 8. USG Corporation.
- C. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).
1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

- D. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content:
1. Sealants: 250 g/L.
 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 3. Sealant Primers for Porous Substrates: 775 g/L.
- E. Accessories: Provide components for each penetration firestop system that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by penetration firestop system manufacturer and approved by qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:
1. Permanent forming/damming/backing materials, including the following:
 - a. Slag-/rock-wool-fiber insulation.
 - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - d. Fillers for sealants.
 2. Temporary forming materials.
 3. Substrate primers.
 4. Collars.
 5. Steel sleeves.

2.3 FILL MATERIALS

- A. General: Provide penetration firestop systems by referencing the types of materials described in this Article. Fill materials are those referred to in directories of referenced testing and inspecting agencies as "fill," "void," or "cavity" materials.
- B. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- C. Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.
- D. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- E. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.
- F. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

- G. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- H. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- I. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives.
- J. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- K. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and other surfaces requiring a nonslumping, gunnable sealant, unless indicated firestop system limits use to nonsag grade for both opening conditions.

2.4 MIXING

- A. For those products requiring mixing before application, comply with penetration firestop system manufacturer's written requirements and instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of work.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing penetration firestop systems to comply with firestop system manufacturer's written requirements and instructions and with the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestop systems.

2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestop systems. Remove loose particles remaining from cleaning operation.
 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where directed in writing by penetration firestop system manufacturer using that manufacturer's approved products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

3.3 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. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.
- 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.
1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.
- D. Install fill materials by proven techniques to produce the following results:
1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 CLEANING AND PROTECTING

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

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

3.5 FIELD QUALITY CONTROL

- A. Contractor will engage a qualified testing agency to perform tests and inspections according to ASTM E2174.
- B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.
- C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

END OF SECTION 078413

SECTION 078443

JOINT FIRESTOPPING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Joints in or between fire-resistance-rated constructions.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.
 - 1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.5 INFORMATIONAL SUBMITTALS

- A. Product test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Approvals according to FM Approvals 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics:
 - 1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Test per testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:

2.2 JOINT FIRESTOPPING SYSTEMS

- A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
- B. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E1966 or UL 2079.
 - 1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.
- C. Basis of Design Products: For each fire-resistive joint system, provide products named in referenced standard. Subject to compliance with requirements, including acceptance by authorities having jurisdiction, equal products by one of the following may be provided:
 - 1. Fire-Resistive Joint Systems:
 - a. A/D Fire Protection Systems Inc.
 - b. Hilti, Inc.
 - c. 3M Fire Protection Products.
 - d. Tremco, Inc.
 - e. United States Gypsum Company.
 - 2. Perimeter Fire-Containment Systems:
 - a. Specified Technologies, Inc.
 - b. United States Gypsum Company.
- D. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E84.

- E. VOC Content: Fire-resistive joint system sealants shall comply with the following limits for VOC content:
 - 1. Architectural Sealants: 250 g/L.
 - 2. Sealant Primers for Nonporous Substrates: 250 g/L.
- F. Accessories: Provide components of joint firestopping systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Clean joints immediately before installing fire-resistive joint systems to comply with fire-resistive joint system manufacturer's written requirements and instructions and the following requirements:
 - 1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.
 - 2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where directed in writing by fire-resistive joint system manufacturer using that manufacturer's approved products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from fire-resistive joint system materials. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates or damaging adjoining surfaces.

3.3 INSTALLATION

- A. General: Install joint firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

- B. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.
- C. Install elastomeric fill materials for joint firestopping systems by proven techniques to produce the following results:
 - 1. Elastomeric fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
 - 2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
 - 3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 CLEANING AND PROTECTING

- A. Clean off excess fill materials adjacent to joints as Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure fire-resistive joint systems are without damage or deterioration at time of Final Acceptance. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

3.5 FIELD QUALITY CONTROL

- A. Inspecting Agency: Contractor will engage a qualified testing agency to perform tests and inspections according to ASTM E2393.
- B. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.
- C. Proceed with enclosing joint firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

END OF SECTION 078443

SECTION 079200

JOINT SEALANTS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Silicone joint sealants.
 - 2. Nonstaining silicone joint sealants.
 - 3. Urethane joint sealants.
 - 4. Mildew-resistant joint sealants.
 - 5. Latex joint sealants.
 - 6. Joint sealant backing materials including cylindrical sealant backing and secondary seals.
- B. Each Contractor is responsible for providing their own penetrations and joint sealants in accordance with the requirements of this Section.
- C. Related Sections include the following, however, not all sections are relevant to all contracts:
 - 1. Division 08 Section 088000 "Glazing" for glazing sealants.
 - 2. Division 09 Section 093013 "Ceramic Tiling" for sealing tile joints.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product, indicating VOC content.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view
- 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. Sample warranties.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C1021 to conduct the testing indicated.

1.7 WARRANTY

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

1.8 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
 2. When joint substrates are wet.
 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

- A. VOC Content: Sealants and sealant primers shall comply with the following:
 1. Architectural sealants shall have a VOC content of 250 g/L or less.

2. Sealants and sealant primers for nonporous substrates shall have a VOC content of 250 g/L or less.
 3. Sealants and sealant primers for porous substrates shall have a VOC content of 775 g/L or less.
 4. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. 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.
- C. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

- A. Silicone, S, NS, 100/50, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.
1. Products: Subject to compliance with requirements, provide product by one of the following:
 - a. BASF Building Systems.
 - b. Dow Corning Corporation.
 - c. GE Advanced Materials - Silicones.
 - d. Pecora Corporation.
 - e. Sika Corporation; Construction Products Division.
 - f. Tremco Incorporated.

2.3 NONSTAINING SILICONE JOINT SEALANTS

- A. Nonstaining Joint Sealants: No staining of substrates when tested according to ASTM C1248.
- B. Silicone, Nonstaining, S, NS, 100/50, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pecora Corporation; 890NST.
 - b. Dow Corning, 790.
 - c. Tremco Incorporated; Spectrum 1.

2.4 URETHANE JOINT SEALANTS

- A. Urethane, S, NS, 25, NT: Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pecora Corporation; Dynatrol I-XL.
 - b. Sika Corporation; Sikaflex 1A.
 - c. Tremco Incorporated; Dymonic.

- B. Urethane, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.
 1. Products: Subject to compliance with requirements, provide the following:
 - a. Pecora Corporation; Dynatrol I-XL.
 - b. Sika Corporation: Sikaflex 15LM.
 - c. Tremco Incorporated; Dymonic 100.

- C. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Corporation-Construction Systems; MasterSeal SL1.
 - b. Pecora Corporation; NR-201.
 - c. Polymeric Systems, Inc; Flexiprene 952.
 - d. Tremco Incorporated; Vulken 455SL.

- D. Urethane, M, NS, 50, T, NT: Multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 50, Uses T and NT.
 1. Products: Subject to compliance with requirements, provide the following:
 - a. Pecora Corporation; Dynatrol II.
 - b. Sika Corporation: Sikaflex 2C
 - c. Tremco Incorporated; Dymeric 240.

- E. Urethane, M, P, 25, T: Multicomponent, pourable, plus 25 percent and minus 25 Urethane, M, P, 25, T, NT: Multicomponent, pourable, plus 25 percent and minus 25 percent movement capability, traffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 25, Uses T, A, and M.
 1. Products: Subject to compliance with requirements, provide the following:
 - a. BASF Corporation-Construction Systems; Masterseal SL2.
 - b. Sika Corporation; Sikaflex 2C-SL.
 - c. Tremco Incorporated; THC-901.

2.5 MILDEW-RESISTANT JOINT SEALANTS

- A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.
- B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. Dow Corning Corporation; 786 Silicone Sealant.
 - b. Pecora Corporation; 898NST.
 - c. Tremco Incorporated; Tremsil 200.

2.6 LATEX JOINT SEALANTS

- A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. BASF Construction Chemicals, LLC, Building Systems; Sonolac.
 - b. May National Associates, Inc., a subsidiary of Sika Corporation U.S.; Bondaflex 600 or Bondaflex Sil-A 700.
 - c. Pecora Corporation; AC-20.
 - d. Sherwin-Williams Company (The); 850A or 950A.
 - e. Tremco Incorporated; Tremflex 834.
- B. Butyl-Rubber-Based Joint Sealant: ASTM C 1311.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Bostik, Inc.; Chem-Calk 300.
 - b. Pecora Corporation; BC-158.
 - c. Tremco Incorporated; Tremco Butyl Sealant.

2.7 JOINT-SEALANT BACKING

- A. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), Type O (open-cell material), Type B (bicellular material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Secondary Seal to Field-Applied Sealants in Above Grade Vertical Walls and where indicated on drawings:

1. Basis of Design Product: Subject to compliance with requirements, provide Backerseal; EMSEAL Joint Systems, Led.; (800) 526-8365; www.emseal.com; or an equal product by another manufacturer.
 2. Description: 100% acrylic impregnated expanding foam sealant with internal laminations of closed cell foam.
- D. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer.

2.8 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 and the following requirements:
 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.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces.

3.2 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with ASTM C1193 and joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

- C. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 1. Provide concave joint profile per Figure 8A in ASTM C1193 unless otherwise indicated.

3.3 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.
 - 1. Joint Locations:
 - a. Isolation and contraction joints in cast-in-place concrete slabs.
 - b. Joints between different materials listed above.
 - c. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Urethane, single component, pourable, traffic grade.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- B. Joint-Sealant Application: Exterior joints in horizontal non-traffic surfaces.
 - 1. Joint Locations:
 - a. Roof edges, flashing, and counterflashing.
 - b. Other joints as indicated on Drawings.
 - 1. Urethane Joint Sealant: Single component, nonsag, NT, Class 100/50
 - 2. Joint-Sealant Color: As selected by Architect from manufacturer's standard range of colors.
- C. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
 - 1. Joint Locations:
 - a. Construction joints in cast-in-place concrete.
 - b. Control and expansion joints in unit masonry.
 - c. Joints in dimension stone cladding.
 - d. Perimeter joints between materials listed above and frames of doors, windows, and louvers.
 - e. Other joints as indicated on Drawings.

2. Joint Sealant: Silicone, nonstaining, nonsag, Class 50.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- D. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
1. Joint Locations:
 - a. Isolation joints in cast-in-place concrete slabs.
 - b. Other joints as indicated on Drawings.
 2. Joint Sealant: Multicomponent, nonsag, traffic grade, Class 50.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- E. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Locations:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Tile control and expansion joints.
 - c. Vertical joints on exposed surfaces of unit masonry walls and partitions.
 - d. Other joints as indicated on Drawings.
 2. Joint Sealant: Urethane, single component, nonsag, Class 25, NT.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- F. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.
1. Joint Locations:
 - a. Control joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints between interior wall surfaces and frames of interior doors windows.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Acrylic latex.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors. Paintable.
- G. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Locations:
 - a. Joints between plumbing fixtures and adjoining walls, floors, counters, and backsplashes.
 - b. Tile control and expansion joints where indicated.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Silicone, mildew resistant, single component, nonsag, Class 25, neutral curing.
 3. Joint-Sealant Color: Clear.

H. Joint-Sealant Application: Concealed mastics.

1. Joint Locations:
 - a. Aluminum thresholds.
 - b. Sill plates.
 - c. Other joints as indicated on Drawings.
2. Joint Sealant: Butyl-rubber based.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 079200

SECTION 081113

HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Exterior standard steel doors and frames.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include the following:
 - 1. Elevations of each door type.
 - 2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
 - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
- C. Product Schedule: For hollow-metal doors and frames, 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.

1.4 INFORMATIONAL SUBMITTALS

- A. Product test reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ceco Door; ASSA ABLOY.
 - 2. Curries Company; ASSA ABLOY.

3. Republic Doors and Frames.
4. Steelcraft; by Allegion.

2.2 PERFORMANCE REQUIREMENTS

- A. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.40 deg Btu/F x h x sq. ft. (2.27 W/K x sq. m) when tested according to ASTM C518.

2.3 EXTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A.

1. Doors:

- a. Type: As indicated in the Door and Frame Schedule.
- b. Thickness: 1-3/4 inches (44.5 mm).
- c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm), with minimum A60 (ZF180) coating.
- d. Edge Construction: Model 2, Seamless.
- e. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
- f. Bottom Edges: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
- g. Core: Polyurethane.

2. Frames:

- a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm), with minimum A60 (ZF180) coating.
- b. Construction: Full profile welded

3. Exposed Finish: Prime

2.4 FRAME ANCHORS

A. Jamb Anchors:

1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
2. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch (1.0 mm) thick, with corrugated or perforated straps not less than 2

inches (50 mm) wide by 10 inches (250 mm) long; or wire anchors not less than 0.177 inch (4.5 mm) thick.

- B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor. Formed from same material as frames, not less than 0.042 inch (1.0mm) thick.
- C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch (51-mm) height adjustment. Terminate bottom of frames at top of underlayment.

2.5 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 A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- C. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- D. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.
- E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.
- F. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- G. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z (12G) coating designation; mill phosphatized.
 - 1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.
- H. Grout: ASTM C 476, except with a maximum slump of 4 inches (102 mm), as measured according to ASTM C 143/C 143M.
- I. Mineral-Fiber Insulation: ASTM C665, 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 E136 for combustion characteristics.
- J. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat.

2.6 FABRICATION

- A. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.

- B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
 - 1. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 2. 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.
- C. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
- D. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
- E. Jamb Anchors: Provide number and spacing of anchors as follows:
 - 1. Masonry Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:
 - a. Two anchors per jamb up to 60 inches (1524 mm) high.
 - b. Three anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
 - c. Four anchors per jamb from 90 to 120 inches (2286 to 3048 mm) high.
 - d. Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 120 inches (3048 mm) high
- F. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to ANSI/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 BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

2.7 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 ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 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. Touch up factory-applied finishes where spreaders are removed.
- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

- A. Hollow-Metal Frames: Comply with ANSI/SDI A250.11.
 - 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
 - a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
 - b. Install frames with removable stops located on secure side of opening.
 - c. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
 - d. Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.
 - 2. Floor Anchors: 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 or mortar.
 - 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 frames to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.

B. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.

1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.

3.3 REPAIR

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.

E. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081113

SECTION 084313

ALUMINUM-FRAMED STOREFRONTS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Aluminum-framed storefront systems.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For aluminum-framed storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.
 - 1. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
- C. Samples: For each type of exposed finish required.
- D. Delegated-Design Submittal: For aluminum-framed storefronts indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Energy Performance Certificates: NFRC-certified energy performance values from manufacturer.
- B. Product test reports.

- C. Source quality-control reports.
- D. Field quality-control reports.
- E. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Testing Agency Qualifications: Qualified in accordance with ASTM E699 for testing indicated and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025 and acceptable to Department and Architect.
- C. 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.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.
 - 1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the following products by Kawneer North America; an Alcoa company: Trifab 451UT 2" x 4 1/2" or comparable product by one of the following:
1. EFCO Corporation.
 2. Oldcastle BuildingEnvelope™.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum-framed storefronts.
- B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
1. Aluminum-framed storefronts shall withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
 2. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Glass breakage.
 - c. Noise or vibration created by wind and thermal and structural movements.
 - d. Loosening or weakening of fasteners, attachments, and other components.
 - e. Failure of operating units.
- C. Structural Loads:
1. Wind Loads: As indicated on Drawings.
 2. Other Design Loads: As indicated on Drawings.
- D. Deflection of Framing Members: At design wind pressure, as follows:
1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite or 1/175 of clear span for spans of up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m) or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19.1 mm), whichever is less.
 2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller.
 - a. Operable Units: Provide a minimum 1/16-inch (1.6-mm) clearance between framing members and operable units.

3. Cantilever Deflection: Where framing members overhang an anchor point, as follows:
 - a. Perpendicular to Plane of Wall: No greater than 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 11 feet 8-1/4 inches (3.6 m) or 1/175 times span, for spans less than 11 feet 8-1/4 inches (3.6 m).
- E. Structural: Test in accordance with ASTM E330/E330M as follows:
 1. When tested at positive and negative wind-load design pressures, storefront assemblies do not evidence deflection exceeding specified limits.
 2. When tested at 150 percent of positive and negative wind-load design pressures, storefront assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
 3. Test Durations: As required by design wind velocity, but not less than 10 seconds.
- F. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:
 1. No evidence of water penetration through fixed glazing and framing areas when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).
- G. Energy Performance: Certified and labelled by manufacturer for energy performance as follows:
 1. Thermal Transmittance (U-factor):
 - a. Fixed Glazing and Framing Areas: U-factor for the system of not more than 0.27 Summer Daytime and 0.27 Winter Nighttime as determined in accordance with NFRC 100.
 2. Solar Heat Gain Coefficient (SHGC):
 - a. Fixed Glazing and Framing Areas: SHGC for the system of not more than 0.27 as determined in accordance with NFRC 200.
 3. Air Leakage:
 - a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than 0.06 cfm/sq. ft. (0.30 L/s per sq. m) at a static-air-pressure differential of 6.24 lbf/sq. ft. (300 Pa) when tested in accordance with ASTM E283.
 4. Condensation Resistance Factor (CRF):
 - a. Fixed Glazing and Framing Areas: CRF for the system of not less than 60 as determined in accordance with AAMA 1503.
- H. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.
 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.3 ALUMINUM-FRAMED STOREFRONT SYSTEMS

- A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
 - 1. Exterior Framing Construction: Thermally broken.
 - 2. Glazing System: Retained mechanically with gaskets on four sides.
 - 3. Glazing Plane: Center
 - 4. Finish: High-performance organic finish
 - 5. Fabrication Method: Field-fabricated stick system.
 - 6. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - 7. Steel Reinforcement: As required by manufacturer.
- 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.

2.4 OPERABLE WINDOWS

- A. Basis of Design Product: Kawneer GLASSvent Project Out Window.
- B. Comply with AAMA/WDMA 101/I.S.2/NAFS.
 - 1. Performance Class and Grade: HC 70.
- C. Materials: Material Standard: ASTM B221; 6063-T6 alloy and temper.
 - 1. Total Frame Depth: Not less than 2-13/16" (71.4 mm) (1" glass)
 - 2. Member Wall Thickness: Each framing member shall have a wall thickness sufficient to meet the specified structural requirements.
 - 3. The frame and ventilator corner construction shall consist of a mitered corner joint with an internal clip, sealed and mechanically staked.
 - 4. The frame shall have a continuous primary weather seal of polyethylene clad urethane foam, the rainscreen weather stripping shall be dual durometer Santoprene. Each corner shall be neatly mitered.
 - 5. The frame and ventilator shall be factory fabricated and assembled.
- D. Hardware: Manufacturer's standard; of aluminum, stainless steel, die-cast steel, malleable iron, or bronze; including the following:
 - 1. Hinges: Non-friction type, not less than two per sash.
 - 2. Lock: Lever handle and cam-action lock with keeper Concealed multipoint lock operated by single lever handle.
 - 3. Exposed Hardware Color and Finish: Oil rubbed bronze (US 10B).
- E. Insect Screens: Provide removable insect screen on each operable exterior sash, with screen frame finished to match window unit, complying with SMA 1004 or SMA 1201, and as follows:

1. General: Fabricate insect screens to integrate with window frame. Provide screen for each operable exterior sash. Screen wickets are not permitted.
 - a. Type and Location: Full, inside for project-out sashes.
 2. Aluminum Frames: Manufacturer's standard aluminum alloy complying with SMA 1004 or SMA 1201. Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, and removable PVC spline/anchor concealing edge of frame.
 - a. Tubular Framing Sections and Cross Braces: Roll formed from aluminum sheet.
 - b. Color: To match window units.
 3. Aluminum Wire Fabric: 18-by-16 (1.1-by-1.3-mm) mesh of 0.011-inch- (0.28-mm-) diameter, coated aluminum wire.
 - a. Wire-Fabric Finish: Charcoal gray.
- F. Glazing: Same as adjacent aluminum-framed storefront glazing.
- G. Finish: Match adjacent aluminum-framed storefront finish.

2.5 GLAZING

- A. Glazing: Comply with Section 088000 "Glazing."
- B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
- C. Glazing Sealants: As recommended by manufacturer.
 1. Sealant shall have a VOC content of 250 g/L or less

2.6 MATERIALS

- A. Sheet and Plate: ASTM B209 (ASTM B209M).
- B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221 (ASTM B221M).
- C. Extruded Structural Pipe and Tubes: ASTM B429/B429M.
- D. Structural Profiles: ASTM B308/B308M.
- E. Steel Reinforcement:
 1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
 2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
 3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.
- F. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.
- G. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2.7 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Physical and thermal isolation of glazing from framing members.
 - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 5. Provisions for field replacement of glazing from exterior.
 - 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- E. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

2.8 ALUMINUM FINISHES

- A. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with AAMA 2604 and containing not less than 70 percent PVDF resin by weight in color coat.
 - 1. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 2. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Comply with manufacturer's written instructions.
- B. Do not install damaged components.
- C. Fit joints to produce hairline joints free of burrs and distortion.
- D. Rigidly secure nonmovement joints.
- E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
- F. Seal perimeter and other joints watertight unless otherwise indicated.

G. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

H. Set continuous sill members and flashing in full sealant bed, as specified in Section 079200 "Joint Sealants," to produce weathertight installation.

I. Install joint filler behind sealant as recommended by sealant manufacturer.

J. Install components plumb and true in alignment with established lines and grades.

3.2 INSTALLATION OF GLAZING

A. Install glazing as specified in Section 088000 "Glazing."

END OF SECTION 084313

SECTION 086250

TUBULAR DAYLIGHTING DEVICE

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. Tubular daylighting device, consisting of roof lens, reflective tube, and diffuser assembly; configuration as indicated on the Contract Drawings.
- B. Accessories.

1.3 PERFORMANCE REQUIREMENTS

- A. Completed tubular daylighting device assemblies shall be capable of meeting the following performance requirements:
 - 1. Air Infiltration Test: Air infiltration will not exceed 0.30 cfm/sf aperture with a pressure delta of 1.57 psf across the tube when tested in accordance with ASTM E 283.
 - 2. Water Resistance Test: No uncontrolled water leakage at 10.5 psf pressure differential with water rate of 5 gallons/hour/sf when tested in accordance with ASTM E 547.
 - 3. Uniform Load Test:
 - a. No breakage, permanent damage to fasteners, hardware parts, or damage to make system inoperable or cause excessive permanent deflection of any section when tested at a Positive Load of 150 psf (7.18 kPa) or Negative Load of 60 psf (2.87 kPa) in accordance with ICC AC-16 Section A, or Negative Load of 70 psf (3.35 kPa) if tested per ICC AC-16 Section B.
 - b. All units shall be tested with a safety factor of (3) for positive pressure and (2) for negative pressure, acting normal to plane of roof in accordance with ASTM E 330.

1.4 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation requirements and instructions.
 - 2. Storage and handling requirements and instructions.
 - 3. Installation methods.

- B. Shop Drawings. Submit shop drawings showing layout, profiles and product components, including anchorage, flashings and accessories.
- C. Verification Samples: As requested by the Department.
- D. Test Reports: Independent testing agency or evaluation service reports verifying compliance with specified performance requirements.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Engaged in manufacture of tubular daylighting devices for minimum 20 years.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.7 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits as directed by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.8 WARRANTY

- A. Daylighting Device: Manufacturer's standard warranty for 10 years.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Model 160 DS Low Profile by Solatube International, Inc or an equal product by one of the following:
 - 1. VELUX USA.
 - 2. Natural Light Energy Systems.

2.2 TUBULAR DAYLIGHTING DEVICES

- A. Tubular Daylighting Devices General: Tubular daylighting device with daylight harvesting and available occupancy controls; complying with ICC AC-16.
- B. Solatube Model 160 –DS Low Profile
 - 1. Low Profile Collector: 10 inch transparent, UV and impact resistant lens with flashing base supporting dome and top of tube.
 - a. Outer Collector Glazing: Type DU 0.125 inch (3 mm) minimum thickness injection molded acrylic classified as CC1 material; UV inhibiting (100 percent UV C, 100 percent UV B and 98.5 percent UV A), impact modified acrylic blend.

- b. Raybender 3000: Variable prism optic molded into outer collector to capture low angle sunlight and limit high angle sunlight.
 - c. LightTracker Reflector: Aluminum sheet, thickness 0.015 inch (0.4 mm) with Spectralight Infinity. Positioned in dome to capture low angle sunlight.
- 2. Flashing Base: One piece, seamless, leak-proof flashing functioning as base support for dome and top of tube.
 - a. Base Material: Sheet steel, corrosion resistant, meeting ASTM A 653/A 653M or ASTM A 463/A 463M or ASTM A792/A 792M, 0.028 inch (0.7 mm) plus or minus .006 inch (.015 mm) thick.
 - b. Base Pitched: Pitched Type FP, to match roof slope.
 - c. Flashing Insulator: Type FI. Thermal isolation material for use under flashing.
- 3. Roof Flashing Turret Extensions: Provide manufacturer's standard extensions in lengths required.
- 4. Tube Ring: Attached to top of base section; 0.090 inch (2.3 mm) nominal thickness injection molded high impact acrylic; to prevent thermal bridging between base flashing and tubing and channel condensed moisture out of tubing.
- 5. Reflective Extension Tube: Aluminum sheet, thickness 0.015 inch (0.4 mm).
 - a. Interior Finish: Spectralight Infinity high reflectance specular finish on exposed reflective surface. Visible spectrum (400 nm to 760 nm) greater than 99 percent. Total solar spectrum (400 nm to 2500 nm) less than 80.2 percent.
 - b. Color: a* and b* (defined by CIE L*a*b* color model) shall not exceed plus 2 or be less than minus 2 as determined in accordance to ASTM E 308.
 - c. Tube Diameter: Approximately 10 inches (250 mm).
- 6. Diffuser Assembly:
 - a. Classic Vision Round

2.3 ACCESSORIES

- A. Fasteners: Same material as metals being fastened, non-magnetic steel, non-corrosive metal of type approved by manufacturer, or injection molded nylon.
- B. Suspension Wire: Steel, annealed, galvanized finish, size and type for application and ceiling system requirement.
- C. Sealant: Polyurethane or copolymer based elastomeric sealant as provided or approved by manufacturer.

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 the Department of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods directed by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Coordinate requirements for power supply, conduit and wiring.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's written requirements and instructions.
- B. After installation of first unit, field test to determine adequacy of installation. Conduct water test in presence of the Department, or their designated representative. Correct if needed before proceeding with installation of subsequent units.

3.4 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Final Inspection.

END OF SECTION 086250

SECTION 087100
DOOR HARDWARE

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes commercial door hardware for the following:
1. Swinging doors.
 2. Sliding doors.
 3. Other doors to the extent indicated.
- B. Door hardware includes, but is not necessarily limited to, the following:
1. Mechanical door hardware.
 2. Cylinders specified for doors in other sections.
- C. Related Sections:
1. Division 08 Section “Hollow Metal Doors and Frames”.
 2. Division 08 Section “Aluminum-Framed Entrances and Storefronts”.
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 2. ICC/IBC - International Building Code.
 3. NFPA 70 - National Electrical Code.
 4. NFPA 80 - Fire Doors and Windows.
 5. NFPA 101 - Life Safety Code.
 6. NFPA 105 - Installation of Smoke Door Assemblies.
 7. State Building Codes, Local Amendments.
- E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:
1. ANSI/BHMA Certified Product Standards - A156 Series.
 2. UL10C - Positive Pressure Fire Tests of Door Assemblies.

3. ANSI/UL 294 - Access Control System Units.
4. ULC-S319 - Electronic Access Control Systems.
5. ULC-60839-11-1, Alarm and Electronic Security Systems - Part 11-1: Electronic Access Control Systems - System and Components Requirements.
6. UL 305 - Panic Hardware.
7. ULC-S132, Emergency Exit and Emergency Fire Exit Hardware.
8. ULC-S533 - Egress Door Securing and Releasing Devices.
9. ANSI/UL 437- Key Locks.
10. ULC-S328, - Burglary Resistant Key Locks.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 - h. Warranty information for each product.
 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

- C. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.
- D. Informational Submittals:
 - 1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- E. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

1.4 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
- B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).
- C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.
- E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
 - 1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
- F. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.

- G. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:
1. Function of building, purpose of each area and degree of security required.
 2. Plans for existing and future key system expansion.
 3. Requirements for key control storage and software.
 4. Installation of permanent keys, cylinder cores and software.
 5. Address and requirements for delivery of keys.
- H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
 2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
 3. Review sequence of operation narratives for each unique access controlled opening.
 4. Review and finalize construction schedule and verify availability of materials.
 5. Review the required inspecting, testing, commissioning, and demonstration procedures
- I. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check

Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

- B. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
 - 1. Structural failures including excessive deflection, cracking, or breakage.
 - 2. Faulty operation of the hardware.
 - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 4. Electrical component defects and failures within the systems operation.
- C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.
- D. Special Warranty Periods:
 - 1. Ten years for mortise locks and latches.
 - 2. Ten years for manual overhead door closer bodies.
 - 3. Twenty five years for manual overhead door closer bodies.

1.8 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.

- B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.
- C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 HANGING DEVICES

- A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.
1. Quantity: Provide the following hinge quantity:
 - a. Two Hinges: For doors with heights up to 60 inches.
 - b. Three Hinges: For doors with heights 61 to 90 inches.
 - c. Four Hinges: For doors with heights 91 to 120 inches.
 - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
 2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
 - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
 - b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
 3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
 - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
 - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
 4. Hinge Options: Comply with the following:
 - a. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.
 5. Manufacturers:
 - a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).

2.3 DOOR OPERATING TRIM

- A. Door Push Plates and Pulls: ANSI/BHMA A156.6 certified door pushes and pulls of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.
1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
 2. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
 3. Manufacturers:
 - a. Burns Manufacturing (BU).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).

2.4 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy. Manufacturer shall be based in the United States of America.
1. Manufacturers:
 - a. Arrow (AW).
 - b. dormakaba Best (BE).
 - c. Falcon Lock (FA).
- B. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:
1. Threaded mortise cylinders with rings and cams to suit hardware application.
 2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
 4. Tubular deadlocks and other auxiliary locks.
 5. International cylinders including Euro profile and Scandinavian Ovals.
 6. Padlock cylinders.
 7. Cam, switch, and other industrial cylinders
 8. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
 9. Keyway: Manufacturer's Standard.Match Facility Standard.Match Facility Restricted Keyway.
- C. Interchangeable Cores: Provide small format interchangeable cores as specified, core insert, removable by use of a special key; usable with other manufacturers' cylinders.
- D. Keying System: The institution shall specify the keyway required and uncombined cored and keys needed.. The combination will be done by the Institution.
1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.

2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
 3. Existing System: Field verify and key cylinders to match Owner's existing system.
- E. 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.
- F. 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.
- G. 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.
- H. Key Quantity: Provide the following minimum number of keys:
1. Change Keys per Cylinder: Two (2)
 2. Master Keys (per Master Key Level/Group): Five (5).
 3. Construction Keys (where required): Ten (10).
- I. Key Registration List (Bitting List):
1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
 2. Provide transcript list in writing or electronic file as directed by the Owner.

2.5 MECHANICAL LOCKS AND LATCHING DEVICES

- A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.
1. Where specified, provide status indicators with highly reflective color and wording for "locked/unlocked" or "vacant/occupied" with custom wording options if required. Indicator to be located above the cylinder with the inside thumb-turn not blocking the visibility of the indicator status. Indicator window size to be a minimum of 2.1" x 0.6" with a curved design allowing a 180 degree viewing angle with protective covering to prevent tampering.
 2. Manufacturers:
 - a. Sargent Manufacturing (SA) - 8200 Series.
 - b. No Substitution.

2.6 AUXILIARY LOCKS

- A. Mortise Deadlocks, Small Case: ANSI/BHMA A156.36, Grade 1, small case mortise type deadlocks constructed of heavy gauge wrought corrosion resistant steel. Steel or stainless steel bolts with a 1" throw and hardened steel roller pins. Deadlocks to be products of the same source manufacturer and keyway as other specified locksets.
1. Manufacturers:
 - a. Sargent Manufacturing (SA) - 4870 Series.
 - b. No Substitution.

2.7 LOCK AND LATCH STRIKES

- A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
 2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
 3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
 4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.
- B. Standards: Comply with the following:
1. Strikes for Mortise Locks and Latches: BHMA A156.13.
 2. Strikes for Bored Locks and Latches: BHMA A156.2.
 3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
 4. Dustproof Strikes: BHMA A156.16.

2.8 ELECTROMECHANICAL EXIT DEVICES

- A. Electromechanical Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed panic and fire exit hardware devices subject to same compliance standards and requirements as mechanical exit devices. Electrified exit devices to be of type and design as specified below and in the hardware sets.
1. Energy Efficient Design: Provide devices which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.
 2. Where conventional power supplies are not sufficient, include any specific controllers required to provide the proper inrush current.

3. Motorized Electric Latch Retraction: Devices with an electric latch retraction feature must use motors which have a maximum current draw of 600mA. Solenoid driven latch retraction is not acceptable.
4. Egress Pathway Exit Devices: Egress pathway devices connect to the building fire alarm system and when activated begin a looping sequence of synchronized signals integrating flashing LEDs, a conical beam laser and white noise followed by voice commands creating clear pathway to safety and emergency exit locations.
5. Electroluminescent Exit Devices: Increase visibility of exit locations supplementing life safety codes requiring egress path marking systems. Integral "EXIT" green-blue electroluminescent signage provides 3 to 5 times the visibility of other light sources. Devices can be used as a stand-alone feature or wired in conjunction with the fire alarm system.
6. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - ED5000 Series.
 - b. dormakaba Precision (PR) - Apex 2000 Series.
 - c. Sargent Manufacturing (SA) - 80 Series.
 - d. Von Duprin (VD) - 35A/98 XP Series.
 - e. Yale (YA) - 7000 Series.
 - f. No Substitution.

B. Electromechanical Push Rail Exit Devices (Commercial Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed panic and fire exit hardware devices subject to same compliance standards and requirements as mechanical exit devices. Electrified exit devices to be of type and design as specified below and in the hardware sets.

1. Where conventional power supplies are not sufficient, include any specific controllers required to provide the proper inrush current.
2. Manufacturers:
 - a. Yale (YA) - 6000 Series.
 - b. No Substitution.

2.9 DOOR CLOSERS

A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.
2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.

3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.
 4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
 5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
 6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.
- B. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.
1. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - DC6000 Series.
 - b. Norton Door Controls (NO) - 7500 Series.
 - c. Sargent Manufacturing (SA) - 351 Series.
- C. Door Closers, Surface Mounted (Cam Action): ANSI/BHMA 156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, high efficiency door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be of the cam and roller design, one piece cast aluminum silicon alloy body with adjustable backcheck and independently controlled valves for closing sweep and latch speed.
1. Manufacturers:
 - a. Norton Door Controls (NO) - 2800ST Series.
 - b. Sargent Manufacturing (SA) - 422 Series.

2.10 ARCHITECTURAL TRIM

A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and

not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.

3. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.
4. Protection Plates: ANSI/BHMA A156.6 certified protection plates (kick, armor, or mop), fabricated from the following:
 - a. Stainless Steel: 300 grade, 050-inch thick.
5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
6. Manufacturers:
 - a. Hiawatha, Inc. (HI).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).

2.11 DOOR STOPS AND HOLDERS

- A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.
- B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
 1. Manufacturers:
 - a. Hiawatha, Inc. (HI).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).

2.12 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.
- C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.
 - 1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.
- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.
- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- F. Manufacturers:
 - 1. National Guard Products (NG).
 - 2. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
 - 3. Reese Enterprises, Inc. (RE).

2.13 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.14 FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
 - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
 - 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
 - 4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and 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 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."
- E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

- A. Field Inspection (Punch Report): Reference Division 01 Sections "Closeout Procedures" and "Cash Allowances". Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.
 - 1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.
 - 2. Submit documentation of incomplete items in the following formats:
 - a. PDF electronic file.
 - b. Electronic formatted file integrated with the Openings Studio™ door opening management software platform.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.
- C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.
1. Quantities listed are for each pair of doors, or for each single door.
 2. The supplier is responsible for handing and sizing all products.
 3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
 4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.

Hardware Sets

Set: 1.0

Doors: A100, A103, A106, B101, CD103

3 Hinge	T4A3386	US32D	MK
1 Classroom Intruder	CPC 70 8238 LNL	US32D	SA
2 SFIC Cylinder	7100CR	US26D	AW
1 Surface Closer (hold open)	CPS7500T	600 x 689	NO
1 Kick Plate	K1050 10" high CSK BEV	US32D	RO
1 Threshold	273x224AFGT x Length Required x MSES25SS		PE
1 Gasketing	S773BL (Head & Jambs)		PE
1 Rain Guard	346C x Width of Frame Head		PE
1 Sweep	3452CNB x Length Required		PE

Set: 2.0

Doors: A102, A104

3 Hinge	T4A3386	US32D	MK
1 Institutional Privacy Lock (occ. Ind.)	CPC V20 70 8257 VN1L	US32D	SA
1 SFIC Cylinder	7100CR	US26D	AW
1 Surface Closer	2800ST	600 x 689	NO
2 Kick Plate	K1050 10" high CSK BEV	US32D	RO
1 Wall Stop	403 (or) 441CU (As Condition Requires)	US26D	RO
1 Threshold	169A x Length Required x MSES25SS		PE
1 Gasketing	S773BL (Head & Jambs)		PE
1 Rain Guard	346C x Width of Frame Head		PE
1 Sweep	315CN x Length Required		PE
1 Bottom Drip Sweep	345A x Length Required		PE

Set: 3.0

Doors: B103, CD101

3 Hinge	T4A3386	US32D	MK
1 Institutional Privacy Lock (occ. Ind.)	CPC V20 70 8257 VN1L	US32D	SA
1 SFIC Cylinder	7100CR	US26D	AW
1 Surface Closer	CPS7500	600 x 689	NO
1 Kick Plate	K1050 10" high CSK BEV	US32D	RO
1 Threshold	273x224AFGT x Length Required x MSES25SS		PE
1 Gasketing	S773BL (Head & Jambs)		PE
1 Rain Guard	346C x Width of Frame Head		PE
1 Sweep	3452CNB x Length Required		PE

Set: 4.0

Doors: A101, A101B, A105, A105B, CD100, CD102

3 Hinge	T4A3386	US32D	MK
1 Classroom Deadlock	CPC LB 70 4877	US32D	SA
1 SFIC Cylinder	7100CR	US26D	AW
1 Door Pull	BF 110-RKW Mtg-Type 1HD	US32D-316	RO
1 Push Plate	70C-RKW	US32D-316	RO
1 Surface Closer	2800ST	600 x 689	NO

2 Kick Plate	K1050 10" high CSK BEV	US32D	RO
1 Wall Stop	403 (or) 441CU (As Condition Requires)	US26D	RO
1 Threshold	169A x Length Required x MSES25SS		PE
1 Gasketing	S773BL (Head & Jambs)		PE
1 Rain Guard	346C x Width of Frame Head		PE
1 Sweep	315CN x Length Required		PE
1 Bottom Drip Sweep	345A x Length Required		PE

Set: 5.0

Doors: B100, B102

3 Hinge	T4A3386	US32D	MK
1 Classroom Deadlock	CPC LB 70 4877	US32D	SA
1 SFIC Cylinder	7100CR	US26D	AW
1 Door Pull	BF 110-RKW Mtg-Type 1HD	US32D-316	RO
1 Push Plate	70C-RKW	US32D-316	RO
1 Surface Closer	CPS7500	600 x 689	NO
1 Kick Plate	K1050 10" high CSK BEV	US32D	RO
1 Threshold	273x224AFGT x Length Required x MSES25SS		PE
1 Gasketing	S773BL (Head & Jambs)		PE
1 Rain Guard	346C x Width of Frame Head		PE
1 Sweep	3452CNB x Length Required		PE

END OF SECTION 087100

SECTION 088000

GLAZING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Glass for storefront framing.
 - 2. Glazing sealants and accessories.

1.3 COORDINATION

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

1.4 PRECONSTRUCTION TESTING

- A. Preconstruction Adhesion and Compatibility Testing: Test each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.
 - 1. Testing will not be required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches (300 mm) square.
- C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.
- D. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

- A. Preconstruction adhesion and compatibility test report.

1.7 QUALITY ASSURANCE

- A. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.
- B. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
 - 2. GANA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
- C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
- D. Thickness: Where glass thickness is indicated it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.

1.8 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
 - 1. Warranty Period: 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. Subject to compliance with requirements, provide products by Guardian Glass; Sunguard, or a comparable product by one of the following:
 - 1. Vitro Architectural Glass (formerly PPG Glass).

2. Pilkington North America

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazing.
- B. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the International Building Code and ASTM E1300.
 - 1. Design Wind Pressures: As indicated on Drawings.
 - 2. Design Snow Loads: As indicated on Drawings.
 - 3. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.
- C. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
 - 1. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
 - 2. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
 - 3. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.3 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.
- B. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
- C. Ceramic-Coated Vision Glass: ASTM C1048, Condition C, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3; and complying with Specification No. 95-1-31 in GANA's "Engineering Standards Manual."

2.4 INSULATING GLASS

- A. Manufacturers: Subject to compliance with requirements, provide products by Guardian Glass; Solar Control Low-E Glass, in locations indicated on drawings.
- B. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E2190.
 - 1. Sealing System: Dual seals with manufacturer's standard primary and secondary.
 - 2. Perimeter Spacer: Aluminum with color selected by Architect.

2.5 INSULATING-GLASS

- A. Glass Type A: Low-E, acid etched insulating glass units.
 - 1. Overall Unit Thickness: 1 inch (25 mm).
 - 2. Thickness of Each Glass Lite: 1/4"
 - 3. Composition: 1/4" Guardian SNX 62/27 Clear #2 – 1/2" air space – 1/4" Extra Clear float acid etch #3, opacity to be determined by architect.

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. Sealant shall contain low VOCs.
 - 4. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
- B. Glazing Sealant:
 - 1. Neutral-curing silicone glazing sealant complying with ASTM C920, Type S, Grade NS, Class 50, Use NT. Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated.

2.7 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:
 - 1. AAMA 804.3 tape, where indicated.
 - 2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 - 3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
 - 1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
 - 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.8 GLAZING GASKETS

- A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:
 - 1. Neoprene complying with ASTM C 864.
 - 2. EPDM complying with ASTM C 864.
 - 3. Silicone complying with ASTM C 1115.
 - 4. Thermoplastic polyolefin rubber complying with ASTM C 1115.
- B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned neoprene, EPDM, silicone, thermoplastic polyolefin rubber gaskets complying with ASTM C 509, Type II; of profile and hardness required to maintain watertight seal.
 - 1. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.
 - 2. Color: gray

2.9 MISCELLANEOUS GLAZING MATERIALS

- A. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- B. Setting Blocks:
 - 1. Elastomeric with a Shore, Type A durometer hardness of 85, plus or minus 5.
 - 2. Type recommended by sealant or glass manufacturer.
- C. Spacers:
 - 1. Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
 - 2. Type recommended by sealant or glass manufacturer.
- D. Edge Blocks:
 - 1. Elastomeric with a Shore A durometer hardness per manufacturer's written instructions.
 - 2. Type recommended by sealant or glass manufacturer.

PART 3 - EXECUTION

3.1 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 (1270 mm).
- 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.

3.2 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Apply heel bead of elastomeric sealant.
- F. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- G. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.3 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.4 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.

END OF SECTION 088000

SECTION 089119

FIXED LOUVERS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section includes fixed extruded-aluminum louvers.
- B. Related Sections:
 - 1. Division 23 “Diffusers, Registers, Grilles, and Louvers”

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
- C. Samples: Color chart for selection and samples for verification.
- D. Product Test Reports: Based on tests performed according to AMCA 500-L.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
 - 3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.5 WARRANTY

- A. Special Finish Warranty: Manufacturer agrees to repair or replace components on which finishes fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors.
 - 1. Wind Loads: Determine loads based on a uniform pressure of 30 lbf/sq. ft., acting inward or outward.
- B. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.
- C. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

2.2 FIXED EXTRUDED-ALUMINUM LOUVERS

- A. Horizontal, Wind-Driven-Rain-Resistant Louver:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Airolite Company, LLC (The).
 - b. Construction Specialties, Inc.
 - c. Ruskin.
 - 2. Louver Depth: 7 inches (178 mm).
 - 3. Frame and Blade Nominal Thickness: Not less than 0.075 inch (1.9 mm) for blades and 0.080 inch (2.03 mm) for frames.
 - 4. Finish: Mill.
 - 5. Louver Screen: 5/8 inch x .040 inch (16 x 1) aluminum bird screen in removable frame. Same type and form of metal as indicated for louver to which screens are attached. Interior face mounted.
 - 6. Louver Performance Ratings:
 - a. Free Area and Air Performance: Minimum 50% free area.
 - b. Wind-Driven Rain Performance: Not less than 95 percent effectiveness when subjected to a rainfall rate of 3 inches (75 mm) per hour and a wind speed of 29 mph (13 m/s) at a core-area intake velocity of 300 fpm (1.5 m/s).

7. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.3 MATERIALS

- A. Aluminum Extrusions: ASTM B221 (ASTM B221M), Alloy 6063-T5, T-52, or T6.
- B. Aluminum Sheet: ASTM B209 (ASTM B209M), Alloy 3003 or 5005, with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Fasteners: Use types and sizes to suit unit installation conditions.
 1. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
 2. For color-finished louvers, use fasteners with heads that match color of louvers.
- D. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, fabricated from stainless-steel components, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing according to ASTM E488/E488M conducted by a qualified testing agency.
- E. Recycled Content of Aluminum Components: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2.4 FABRICATION

- A. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- B. Join frame members to each other and to fixed louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.5 ALUMINUM FINISHES

- A. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 50 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 1. Color and Gloss: As selected by Architect from manufacturer's full range to match aluminum storefront color.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.

- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- D. Protect unpainted galvanized- and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

3.2 ADJUSTING

- A. Restore louvers damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

END OF SECTION 089119

SECTION 093013
CERAMIC TILING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Glazed wall tile and trim.
 - 2. Tile backing panels.
 - 3. Waterproof membrane.

1.3 REFERENCES

- A. ANSI A108 Series/A118 Series - American National Standards for Installation of Ceramic Tile.
- B. ANSI A137.1 - American National Standard Specifications for Ceramic Tile.
- C. TCNA (HB) - Handbook for Ceramic, Glass and Stone Tile Installation; Tile Council of North America.
- D. TTMAC - Tile Specification Guide 09 30 00 Tile Installation Manual.
- E. ISO 13007 - International Standards Organization; classification for Grout and Adhesives.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data for all products.
 - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
- C. Samples:
 - 1. Each type and composition of tile and for each color and finish required.

2. Color charts for initial selection of grout. 6-in length sample of selected colors for final selection of grout.

1.5 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 1. Build mockup of wall tile installation.
 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- B. Source Limitations: Provide grout materials, setting materials, and waterproofing/crack isolation membrane by a single manufacturer.

1.6 WARRANTY

- A. Provide Manufacturer's standard 25-year systems warranty for grout materials, setting materials, and waterproofing/crack isolation membrane.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide Standard-grade tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

2.2 TILE PRODUCTS

- A. Colorbody Porcelain
 1. Manufacturers: Subject to compliance with requirements and suitable for unheated buildings, provide products by Daltile, Keystones Collection, or a comparable product by the following:
 - a. American Olean.
 - b. Subway Ceramics.
 - c. Mohawk Marble and Tile.
 2. Module Size: 2 by 4 inches (76 by 152 mm).
 3. Face Size Variation: Rectified.
 4. Thickness: 1/4 inch

5. Face: Plain with modified square edges.
6. Finish: Matte
7. Tile Color and Pattern: Arctic White (D617), stacked bond pattern.
8. Grout Color: As selected by Architect from manufacturer's full range.
9. Mounting: Factory, back mounted.
10. Manufacturing: products made in USA.
11. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Cap: Surface bullnose.
 - b. External Corners: Surface bullnose, same size as adjoining flat tile.
 - c. Internal Corners: Field-buttet square corners. For coved base and cap use angle pieces designed to fit with stretcher shapes.

2.3 TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A118.9 or ASTM C1325, Type A.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Custom Building Products, Wonderboard.
 - b. National Gypsum, PermaBASE.
 - c. USG Corporation, Durock.
 2. Thickness: 1/2 inch (12.7 mm).

2.4 WATERPROOF AND CRACK ISOLATION MEMBRANE

- A. General: Manufacturer's standard product that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Location: To be installed on shower enclosure walls and flooring. Waterproofing membrane to be continuous on all tiled walls.
- C. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
 1. Manufacturers: Subject to compliance with requirements, provide products by Mapei, Mapelastic AquaDefense, or one of the following:
 - a. Laticrete International, Inc.
 - b. Bonsal American, an Oldcastle company.
 - c. Bostik, Inc.
 - d. Custom Building Products.

2.5 SETTING MATERIALS

- A. Modified Dry-Set Mortar (Thinset): ANSI A118.4.

1. Manufacturers: Subject to compliance with requirements, provide products by Mapei, Ultraflex 2, or one of the following:
 - a. Laticrete International, Inc.
 - b. Bonsal American, an Oldcastle company.
 - c. Bostik, Inc.
 - d. Custom Building Products.
2. Provide prepackaged, dry-mortar mix to which only water must be added at Project site.
3. For wall applications, provide nonsagging mortar.

2.6 GROUT MATERIALS

A. High-Performance Tile Grout: ANSI A118.7.

1. Manufacturers: Subject to compliance with requirements, provide products by Mapei, Ultracolor Plus FA, or one of the following:
 - a. Laticrete International, Inc.
 - b. Bonsal American, an Oldcastle company.
 - c. Bostik, Inc.
 - d. Custom Building Products.
2. Polymer Type: Dry, redispersible form, prepackaged with other dry ingredients.
3. Joint size: 1/16 inch.
4. Color: as selected by Architect from manufacturer's standard range.

2.7 FLEXIBLE SEALANT

- A. Professional-grade, 100%-silicone sealant specifically formulated for heavy traffic expansion and movement joints, horizontal and vertical complying with ASTM standards; slump (ASTM C639), tack-free time (ASTM C679,) shore "A" hardness (ASTM C661), joint movement (ASTM C920), elongation at break (ASTM D412), and flexibility (ASTM C734). Sealant to be installed in corner control joints.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide MAPEI Corporation; Mapesil T or a comparable product by one of the following:
 - a. Laticrete International, Inc.
 - b. Bonsal American, an Oldcastle company.
 - c. Bostik, Inc.
 - d. Custom Building Products.
 2. Color: as selected by Architect from manufacturer's standard range to match grout color.

2.8 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

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.
- 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. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot (1:50) toward drains.

3.3 INSTALLATION

- A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
 - 1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
 - a. Tile walls in wet areas.
 - b. Tile floors consisting of tiles 8 by 8 inches (200 by 200 mm) or larger.
 - c. Tile floors consisting of rib-backed tiles.

- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Where accent tile differs in thickness from field tile, vary setting bed thickness so that tiles are flush.
- F. Jointing Pattern: Lay tile in running bond pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in 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.
- G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
 - 1. Glazed Wall Tile: 1/16 inch.
- H. Control Joints: Provide control 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 or concrete masonry substrates, locate joints in tile surfaces directly above or in front of them.
- I. Install tile backing panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated.
- J. Install waterproof membrane to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.
- K. 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.

END OF SECTION 093013

SECTION 096723

RESINOUS FLOORING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section includes surface preparation and the application of high-performance coating systems on interior concrete floors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include manufacturer's technical data, application instructions, and recommendations for each resinous flooring component required.
- B. Samples for Verification: For each resinous flooring system required, 6 inches (150 mm) square, applied to a rigid backing by Installer for this Project.
- C. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.
- D. Sustainable Design Submittals:
 - 1. Product Data: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
 - 2. Product Data: For flooring materials, including printed statement of VOC content.
- E. Samples: For each type of coating system and in each color and gloss of topcoat indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Maintenance Data.
- B. Manufacturer’s Standard Warranty

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer (applicator) who is experienced in applying resinous flooring systems similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance, and who is acceptable to resinous flooring manufacturer.
 - 1. Contractor shall have completed at least 10 projects of similar size and complexity.
- B. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, water proofing membranes, hardening agents, grouting coats, broadcast aggregates and topcoats through one source from a single manufacturer, with not less than ten years of successful experience in manufacturing and installing principal materials described in this section. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.
- C. Manufacturer Field Technical Service Representatives: Resinous flooring manufacture shall retain the services of Field Technical Service Representatives who are trained specifically on installing the system to be used on the project.
 - 1. Field Technical Services Representatives shall be employed by the system manufacture to assist in the quality assurance and quality control process of the installation and shall be available to perform field problem solving issues with the installer.
- D. Mockups: Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.
- B. Store materials to prevent deterioration from moisture, heat, cold, direct sunlight, or other detrimental effects.
- C. All materials used shall be factory pre-weighed and pre-packaged in single, easy to manage batches to eliminate on site mixing errors. No on site weighing or volumetric measurements allowed.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.

1. Maintain material and substrate temperature between 65 and 85 deg F (18 and 30 deg C) during resinous flooring application and for not less than 24 hours after application.
- B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.
- C. Close spaces to traffic during resinous flooring application and for not less than 24 hours after application, unless manufacturer recommends a longer period.
- D. Concrete substrate shall be properly cured. A vapor barrier must be present for concrete subfloors on or below grade.

1.6 WARRANTY

- A. Manufacturer shall furnish a single, written warranty covering both material and workmanship for a period of (1) full years from date of installation, or provide a joint and several warranty signed on a single document by material manufacturer and applicator jointly and severally warranting the materials and workmanship for a period of (1) full year from date of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design Product: Subject to compliance with requirements, provide Stonsheild SLT as manufactured by Stonhard, Inc. or comparable product by of the following:
 1. Dexotex.
 2. Sherwin Williams.
 3. Dur-A-Flex.

2.2 RESINOUS FLOORING SYSTEM

- A. System Characteristics:
 1. Wearing Surface: Standard or medium.
 2. Integral Cove Base: 4 inches
 3. Overall System Thickness: Nominal 2 mm.
 4. Color and Pattern: Architect to select from manufacturer's standard range.
- B. System Components: Manufacturer's standard components that are compatible with each other and as listed below:
 1. Primer
 - a. Material Basis: Stonhard Standard Primer
 - b. Resin: Epoxy
 - c. Formulation Description: (2) two component, 100 percent solids, UV stable.
 - d. Application Method: Squeegee and roller.
 - e. Number of Coats: (1) one.
 2. Undercoat:
 - a. Material Basis: Stonshield undercoat.

- b. Resin: Epoxy
 - c. Formulation Description: (2) two-component, 100% solids, UV Stable.
 - d. Type: Clear.
 - e. Finish: Gloss.
 - f. Number of Coats: one.
3. Broadcast Media:
- a. Material Basis: Stonshield quartz aggregate
 - b. Type: pigmented.
 - c. Finish: standard.
 - d. Number of Coats: one.
 - e. Pattern: Tweed.
4. Sealer:
- a. Material Basis: Stonkote CE4.
 - b. Resin: Epoxy
 - c. Formulation Description: (2) two-component, 100% solids, UV Stable.
 - d. Type: Clear.
 - e. Finish: Gloss.
 - f. Number of Coats: one.
 - g. Texture level: Standard or medium.
- C. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:
- 1. Tensile Strength: 1,600 psi per ASTM C307
 - 2. Flexural Strength: 4,000 psi per ASTM C580
 - 3. Flexural Modulus of Elasticity: 1.0×10^6 psi per ASTM C580
 - 4. Hardness: 85 to 90 per ASTM D2240, Shore D
 - 5. Impact Resistance: > 160 in./lbs. per ASTM D2794
 - 6. Abrasion Resistance: 0.06 gm max. weight loss per ASTM D 4060, CS-17
 - 7. Flammability: Class 1 per ASTM E-648.
 - 8. Thermal Coefficient of Linear Expansion: 1.4×10^{-5} in./in. °F
 - 9. Water Absorption: 0.1% per ASTM C 413
 - 10. VOC Content per ASTM D2369:
 - a. Stonshield Undercoat – 34 g/l
 - b. Stonkote CE4 – 34 g/l
 - 11. Cure Rate @ 77°F/25°C: 12 hours foot traffic, 24 hours normal operations

2.3 ACCESSORY MATERIALS

- A. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.
- B. Joint Sealant: Type recommended or produced by resinous flooring manufacturer for type of service and joint condition indicated. Allowances should be included for **Stonflex MP7 joint fill material**, and CT5 concrete crack treatment.
- C. Pitch materials, use of Stonset TG5 required for all areas that require positive pitch to drains.

PART 3 - EXECUTION

3.0 PREPARATION

- A. General: Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry, and neutral Ph substrate for resinous flooring application
- B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring. Prior to epoxy installation:
 - 1. Mechanically prepare substrates as follows:
 - a. Includes use of a scabblers, scarifier or shot blast machine for removal of bond inhibiting materials such as curing compounds or laitance.
 - b. Hand diamond grind near walls and obstructions.
 - c. Comply with ASTM C 811 requirements, unless manufacturer's written instructions are more stringent.
 - 2. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written recommendations.
 - 3. Verify that concrete substrates meet the following requirements:
 - a. Perform in situ probe test, ASTM F 2170. Proceed with application only after substrates do not exceed a maximum potential equilibrium relative humidity of 85 percent.
 - b. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with application only after substrates have maximum moisture-vapor-emission rate of 6 lb of water/1000 sq. ft. of slab in 24 hours.
 - c. Perform moisture tests recommended by manufacturer. Proceed with application only after substrates pass testing.
 - 4. Verify that concrete substrates have neutral Ph and that resinous flooring will adhere to them. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.
- C. Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.
- D. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written recommendations. Allowances should be included for Stonflex MP7 joint fill material, and CT5 concrete crack treatment.

3.2 APPLICATION

- A. General: Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
 - 1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
 - 2. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
 - 3. At substrate expansion and isolation joints, provide joint in resinous flooring to comply with resinous flooring manufacturer's written recommendations.

- a. Apply joint sealant to comply with manufacturer's written recommendations.
- B. Integral Cove Base: Stonshield cove mortar, apply cove base mix to wall surfaces before applying flooring. Apply according to manufacturer's written instructions and details including those for taping, mixing, priming, troweling, sanding, of cove base. Round internal and external corners.
 1. Integral Cove Base: 4" inches high.
- C. Apply primer where required by resinous system, over prepared substrate at manufacturer's recommended spreading rate.
- D. Apply metal trowel single mortar coat in thickness indicated for flooring system into wet primer. Hand or power trowel and grout to fill voids. When cured, sand to remove trowel marks and roughness.
- E. Undercoat: Remove any surface irregularities by lightly abrading and vacuuming the floor surface. Mix and apply undercoat with strict adherence to manufacturer's installation procedures and coverage rates.
- F. Broadcast: Immediately broadcast quartz silica aggregate into the undercoat using manufacturer's specially designed spray caster. Strict adherence to manufacturer's installation procedures and coverage rates is imperative.
- G. Apply topcoat(s) in number of coats indicated for flooring system and at spreading rates recommended in writing by manufacturer.

3.3 TERMINATIONS

- A. Chase edges to "lock" the flooring system into the concrete substrate along lines of termination.
- B. Penetration Treatment: Lap and seal resinous system onto the perimeter of the penetrating item by bridging over compatible elastomer at the interface to compensate for possible movement.
- C. Trenches: Continue flooring system into trenches to maintain monolithic protection. Treat cold joints to assure bridging of potential cracks.
- D. Treat floor drains by chasing the flooring system to lock in place at point of termination.

3.4 JOINTS AND CRACKS

- A. Treat control joints to bridge potential cracks and to maintain monolithic protection.
- B. Treat cold joints and construction joints and to maintain monolithic protection on horizontal and vertical surfaces as well as horizontal and vertical interfaces.
- C. Vertical and horizontal contraction and expansion joints are treated by installing backer rod and compatible sealant after coating installation is completed. Provide sealant type recommended by manufacturer for traffic conditions and chemical exposures to be encountered.

3.5 CLEANING, PROTECTING, AND CURING

- A. Cure resinous flooring materials in compliance with manufacturer's directions, taking care to prevent contamination during stages of application and prior to completion of curing process. Close area of application for a minimum of 24 hours.
- B. Protect resinous flooring materials from damage and wear during construction operation. Where temporary covering is required for this purpose, comply with manufacturer's recommendations for protective materials and method of application. General Contractor is responsible for protection and cleaning of surfaces after final coats.
- C. Cleaning: Remove temporary covering and clean resinous flooring just prior to final inspection. Use cleaning materials and procedures recommended by resinous flooring manufacturer. General contractor is responsible for cleaning prior to inspection.

END OF SECTION 096723

SECTION 099113

PAINTING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section includes surface preparation and the application of paint systems on the following exterior substrates:
 - 1. Fiber-cement board.
 - 2. Steel exterior doors and frames.
 - 3. Exposed plywood at dish washing sinks.
 - 4. Galvanized metal.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements, application instructions and VOC content.
- B. Samples: For each type of paint system and each color and gloss of topcoat.

1.4 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. (3.8 L) of each material and color applied.

1.5 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each paint system.

- a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
 - b. Other Items: Architect will designate items or areas required.
2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Department.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L
2. Nonflat Paints and Coatings: 50 g/L.
3. Dry-Fog Coatings: 150 g/L.
4. Primers, Sealers, and Undercoaters: 100 g/L.
5. Rust-Preventive Coatings: 100 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 400 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Shellacs, Clear: 730 g/L.
9. Shellacs, Pigmented: 550 g/L.

C. Low-Emitting Materials: For field applications that are inside the weatherproofing system, 90 percent of paints and coatings shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

D. Colors: As selected from manufacturer's standard color range.

E. Products: Subject to compliance with requirements, provide the product listed in the paint and coatings schedules The Sherwin-Williams Company; or an approved equal product by one of the following manufacturers:

- a. Benjamin Moore & Company.
- b. PPG Industries, Inc.

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. Fiber-Cement Board: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- 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 and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and 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 PAINTING SCHEDULE

A. Steel and Galvanized Metal Substrates:

1. Acrylic Enamel System:

- a. Prime Coat: ProCryl Universal Primer.
- b. Intermediate and Topcoats: DTM Acrylic Enamel Finish, Semi-Gloss.

B. Fiber Cement Substrates: including siding and trim.

1. Acrylic Latex over Factory Primer System.

- a. Prime Coat: Loxon Concrete and Masonry Primer.
- b. Intermediate and Topcoats: A-100 Exterior Latex, Gloss.

2. Exposed Fasteners: Sink, fill and paint any exposed fasteners

C. Wood Substrates: Wood and wood-based panel products.

1. Acrylic Latex over Alkyd Primer System.

- a. Prime Coat: Exterior Latex Wood Primer.
- b. Intermediate and Topcoats: A-100 Exterior Latex, Gloss.

D. Insulation-Covering Substrates: Including pipe and duct coverings.

1. Institutional Low-Odor/VOC Latex System:

- a. Prime Coat: ProMar 200 Zero VOC Primer.
- b. Intermediate and Topcoats: ProMar 200 Zero VOC flat.

END OF SECTION 099113

SECTION 101423

PANEL SIGNAGE

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Panel signs.

1.3 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."

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include VOC content for adhesives.
- B. Shop Drawings: For panel 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, including raised characters and Braille, and layout for each sign.
- C. Samples: For each exposed product and for each color and texture specified.

1.5 INFORMATIONAL SUBMITTALS

- A. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

1.8 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with applicable provisions in ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Signs and supporting elements shall withstand the effects of gravity and other loads within limits and under conditions indicated.
- B. Thermal Movements: For exterior signs, 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.
- C. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design", the ABA standards of the Federal agency having jurisdiction, and ICC A117.1.

2.2 PANEL SIGNS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or an equal product approved by the Department:
 - 1. APCO Graphics, Inc.
 - 2. Bunting Graphics, Inc.
 - 3. Mohawk Sign Systems.
 - 4. Nelson-Harkins Industries.
- A. Exterior Panel Signs: Provide smooth sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch (1.5 mm) measured diagonally from corner to corner, complying with the following requirements:
 - 1. Acrylic Sheet: 0.060 inch (1.52 mm) thick.

2. Edge Condition: Square cut.
 3. Corner Condition: Square.
 4. Mounting: Unframed.
 - a. Wall mounted.
 - b. Manufacturer's standard noncorroding anchors for substrates encountered.
 5. Color: As selected by Architect from manufacturer's full range.
- B. Brackets at Stone Walls: Concealed mounting bracket or device suitable for mounting flat sign on irregular stone surface. Factory paint brackets in color matching background color of panel sign.
- C. 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 or clear acrylic sheet with opaque color coating, subsurface applied.
 2. Raised-Copy Thickness: Not less than 1/32 inch (0.8 mm).

2.3 ACRYLIC SHEET FINISHES

- A. 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 that are UV and water resistant for three years for application intended.

2.4 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 unless otherwise indicated:
1. Use concealed fasteners and anchors unless indicated to be exposed.
 2. For exterior exposure, furnish nonferrous-metal or hot-dip galvanized devices unless otherwise indicated.
 3. Sign Mounting Fasteners:
 - a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material or screwed into back of sign assembly unless otherwise indicated.
 - b. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material or screwed into back of sign assembly, unless otherwise indicated.
- A. Adhesive: As recommended by sign manufacturer and with a VOC content of 70 g/L or less for adhesives used inside the weatherproofing system and applied on-site when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- B. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch (1.14 mm) thick, with adhesive on both sides.

2.5 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
 - 1. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 - 2. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
 - 3. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 - 4. Internally brace signs for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
 - 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 sign finish.

2.6 ACRYLIC SHEET FINISHES

- A. 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 that are UV and water resistant for three years for application intended.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Install signs so they do not protrude or obstruct according to the accessibility standard.
 - 3. Before installation, verify that sign 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. Wall-Mounted Signs: Comply with sign manufacturer's written instructions except where more stringent requirements apply:

1. 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.
2. 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.
3. Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position so that signage 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 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.
5. 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.

END OF SECTION 101423

SECTION 102100

PLASTIC TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:

- 1. Solid-plastic toilet compartments configured as toilet enclosures and urinal screens.
- 2. Solid-plastic changing stalls.
- 3. Solid-plastic changing stall and ADA stall benches.

B. Related Sections:

- 1. Section 102800 “Toilet and Bath Accessories.”

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include postconsumer and preconsumer recycled content and low emitting lab test reports for adhesives.
- B. Shop Drawings: For solid-plastic toilet compartments.
 - 1. Include plans, elevations, sections, details, and attachment details.
- C. Samples: For each type of toilet compartment material indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates:

- 1. Product Certificates

1.5 WARRANTY

- A. Manufacturer’s Warranty: Manufacturer’s standard 25 year limited warranty for panels, doors, and stiles against breakage, corrosion, and defects in factory workmanship. Manufacturer’s

standard 1 year guarantee against defects in material and workmanship for stainless steel door hardware and mounting brackets.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance data.

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: 76-200.
 - 2. Smoke-Developed Index: 450 or less.
 - 3. Graffiti Resistance (ASTM D 6578): Passed cleanability test; 5 staining agents.
 - 4. Scratch Resistance (ASTM D 2197): Maximum load value exceeds 10 kilograms.
 - 5. Impact Resistance (ASTM D 2794): Maximum impact force exceeds 30 inch-pounds.
- B. Regulatory Requirements: Comply with applicable provisions in the U.S. Department of Justice "2010 ADA Standards for Accessible Design" and ICC A117.1 for toilet compartments designated as accessible.

2.2 SOLID-PLASTIC TOILET COMPARTMENTS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Scranton Products Hiny Hiders Toilet Partitions - an equal product by one of the following:
 - 1. Global Partitions, an ASI Group Company.
 - 2. General Partitions Mfg. Corp.
 - 3. Accurate Partitions Corp., an ASI Group Company.
 - 4. Or approved equal.
- B. Design: Gap-free interlocking design
- C. Color: As selected by Architect from manufacturer's full line of standard colors.
- D. Toilet-Enclosure Style: Floor mounted, Overhead braced
- E. Urinal-Screen Style: Wall hung
- F. Door, Panel, Screen, and Pilaster Construction: Solid, high-density polyethylene (HDPE) panel material, not less than 1 inch (25 mm) thick, seamless, with eased edges, no-sightline system, and with homogenous color and pattern throughout thickness of material.
 - 1. Integral Hinges: Configure doors and pilasters to receive integral hinges.

2. Heat-Sink Strip: Manufacturer's standard continuous, stainless steel strip fastened to exposed bottom edges of solid-plastic components to hinder malicious combustion.
 3. Color and Pattern: As selected by Architect from manufacturer's full range.
- G. Pilaster Shoes: Manufacturer's standard design; stainless steel.
- H. Urinal-Screen Post: Manufacturer's standard post design of material matching the thickness and construction of pilasters.
- I. Brackets (Fittings):
1. Full-Height (Continuous) Type: Manufacturer's standard design; stainless steel.
- J. Partition Mounted Changing Stall Bench
1. Scranton Products, Tufftec HDPE Bench
 2. Material and Finish: Architect to select from Manufacturer's full standard range.
- K. ADA Shower Stall and Family Assisted Room Benches
1. Scranton Products, Tufftec HDPE Bench top
 2. Mounted to CMU with Rakks bracket: Surface Mount EH Bench Support Bracket.

2.3 HARDWARE AND ACCESSORIES

- A. Hardware and Accessories, Heavy Duty: Manufacturer's vandal-resistant heavy-duty stainless steel operating hardware and accessories.
1. Compliance: Operable with one hand, without tight grasping, pinching, or twisting of the wrist, and force to operate does not exceed five pounds.
 2. Emergency Access: Hinges, latch allow door to be lifted over keeper from outside compartment on inswing doors.
 3. Materials: 18-8, Type 304, heavy-gauge stainless steel with satin finish. Chrome-plated "Zamak", aluminum, or extruded plastic hardware not acceptable.
 4. Hinges: 16 gauge (1.6 mm) stainless steel, self-closing, 3 section hinges.
 5. Latching: 14 gauge (2 mm) sliding door latch, 11 gauge (3.2 mm) keeper; latch slides on a shock-resistant nylon track. Twist-style door latch operation not acceptable.
 6. Clothes Hooks: Projecting no more than 1-1/8 inch (29 mm) from face of door.
 7. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors.
 8. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.
 9. Mounting Brackets: 18 gauge (1.2 mm) stainless steel and extend full height of panel.
- 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.

1. Fastening: Hardware secured to door and stile by through-bolted, theft-resistant, pin-in-head Torx stainless steel machine screws into factory-installed, threaded brass inserts. Fasteners secured directly into core not acceptable.
2. Threaded Brass Inserts: Factory-installed; withstand direct pull force exceeding 1500 lb (680 kg) per insert.

2.4 SOLID PLASTIC SHOWER AND DRESSING COMPARTMENTS

- A. Plastic privacy screens in shower room applications as indicated.
- B. Panels and Pilasters: 1 inch (25 mm) thick with edges rounded to a radius. Mount screens at 14 inches (356 mm) above the finished floor. Color as selected by Architect from manufacturer's full line of standard colors.
 1. Recycled content: Minimum 25 percent.
- C. Type: Floor mounted pilaster supported screen.
 1. Panel Screens: 76 inches (1930 mm) high.
 2. Pilaster Screens: 82 inches (2083 mm) high.
 3. Headrail: Heavy-duty extruded 6463-T5 alloy aluminum with anti-grip design and integrated curtain track. Clear anodized finish. Fastened to the headrail bracket with a stainless steel tamper resistant Torx head sex bolt, and fastened at the top of the pilaster with stainless steel tamper resistant Torx head screws.
 4. Headrail Brackets: 20 gauge stainless steel with a satin finish. Secured to the wall with stainless steel tamper resistant Torx head screws.
 5. Pilaster Sleeves: Type 304, 20 gauge stainless steel. 3 inches (76 mm) high. Secured to pilaster with stainless steel tamper resistant Torx head sex bolt.
 6. Wall Brackets: Continuous, heavy-duty 6463-T5 alloy aluminum. Bright dip anodized finish. Fastened to panel/pilaster with stainless steel tamper resistant Torx head sex bolts.

2.5 MATERIALS

- A. Plastic Panels: High density polyethylene (HDPE) suitable for exposed applications, waterproof, non-absorbent, and graffiti-resistant textured surface.
 1. Recycled Content; Post Industrial: 100 percent
 2. Recycled Content; Post Consumer: 100 percent
- B. Aluminum Castings: ASTM B26/B26M.
- C. Aluminum Extrusions: ASTM B221 (ASTM B221M).
- D. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.
- E. Stainless Steel Castings: ASTM A743/A743M.

- F. Zamac: ASTM B86, commercial zinc-alloy die castings.

2.6 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: Unless otherwise indicated, provide 24-inch- (610-mm-) wide, inswinging doors for standard toilet 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 INSTALLATION OF PLASTIC TOILET COMPARTMENTS

- A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
 - 1. Maximum Clearances:
 - a. Pilasters and Panels: 1/2 inch (13 mm).
 - b. Panels and Walls: 1 inch (25 mm).
 - 2. Full-Height (Continuous) Brackets: Secure panels to walls and to pilasters with full-height brackets.
 - a. Locate bracket fasteners, so holes for wall anchors occur in masonry or tile joints.
 - b. Align brackets at pilasters with brackets at walls.
- B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches (44 mm) 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.
- D. Changing Stall Benches: Install benches depicted on drawings, mounted on changing stall partitions. At ADA shower changing stalls, provide bench to be anchored to block wall as shown on drawings.

3.2 ADJUSTING

- A. Hardware Adjustment: Adjust and lubricate hardware according to 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.

END OF SECTION 102100

SECTION 102800

TOILET AND SHOWER ACCESSORIES

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Public-use washroom accessories.
 - 2. Public-use shower room accessories.
 - 3. Warm-air dryers.
 - 4. Childcare accessories.
 - 5. Underlavatory guards.
 - 6. Custodial accessories.

1.3 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.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
- B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
 - 1. Identify locations using room designations indicated.
 - 2. Identify accessories using designations indicated.

1.5 INFORMATIONAL SUBMITTALS

- A. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.7 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. Warranty Period: 15 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. Basis-of-Design Products: Subject to compliance with requirements, provide product indicated in Schedules or an equal product by one of the following:
 - 1. Bobrick Washroom Equip.
 - 2. A & J Washroom Accessories, Inc.
 - 3. American Specialties, Inc.
 - 4. Or approved equal.
- B. Toilet Tissue (Jumbo Roll) Dispenser
 - 1. Basis-of-Design Product: Bradley; Model 5425.
 - 2. Description: Double jumbo-roll dispenser.
 - 3. Mounting: Surface mounted with concealed anchorage.
 - 4. Capacity: Designed for 9-inch-diameter tissue rolls.
 - 5. Material and Finish: 18 gauge satin finish stainless steel
- C. Liquid-Soap Dispenser:
 - 1. Basis-of-Design Product: Bradley; Model 6A01-11.
 - 2. Description: Designed for dispensing soap in foam form. ADA compliant.
 - 3. Mounting: Vertically oriented, surface mounted.
 - 4. Capacity: 800 ml.
 - 5. Material and Finish: Heavy gauge stainless steel.

6. Lockset: Manufacturer's standard

D. Sanitary-Napkin Disposal:

1. Basis-of-Design Product: Bradley; Model 4722-15.
2. Description: Surface-mounted napkin disposal with push-flap door.
3. Mounting: Vertically oriented, surface mounted.
4. Capacity: 1.5 gallons.
5. Materials: 22 gauge stainless steel cabinet.
6. Lockset: Tumbler type.

E. Grab Bar:

1. Basis-of-Design Product: Bradley; Model 837.
2. Mounting: Flanges with concealed fasteners.
3. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
 - a. Finish: Smooth, No. 4 finish (satin) on ends and slip-resistant texture in grip area.
4. Outside Diameter: 1-1/4 inches (32 mm).
5. Configuration and Length: As indicated on the Contract Drawings.

F. Mirror:

1. Basis-of-Design Product for Mirror: Bradley; Model 747, frameless mirror.
2. Mirror: First quality 1/4" float glass, triple silver plated with electro-copper-plated layer and thermosetting infrared-cured paint backing, manufactured in accordance with ASTM C 1036.
3. Basis of Design Product for Mirror Mount System: Subject to compliance with requirements, provide C.R. Laurence Co., Inc.; www.crlaurence.com; CRL Mirror Mount System, or an equal product by another manufacturer, consisting of the following elements.
 - a. Bottom Channel: CRL Model Number D638A Satin Anodized FHA Type J-channel, designed to prevent moisture from being trapped behind the mirror while concealing screws and support hardware.
 - b. Top Channel: CRL Model Number D1638A Satin Anodized Top Channel.
 - c. Cleat: CRL Mill Mirror Mount System Cleat, designed to hold the mirror away from direct contact with the wall surface.
4. Size: As indicated on the Contract Drawings.

G. Robe Hook (toilet partition door mounted):

1. Bradley, model 9114.
2. Description: Single-prong unit.
3. Material and Finish: Stainless steel, No. 4 finish (satin).

H. Waste Receptacle

1. Bradley, model 3565

2. Description: Surface-mounted 12 gallon waste receptacle
3. Material and Finish: 22 gauge stainless steel, satin finish

2.3 PUBLIC-USE SHOWER ROOM ACCESSORIES

A. Shower Curtain Rod:

1. Bradley, Model 9538.
2. Description: 1-1/4-inch (32-mm) OD; fabricated from nominal 0.05-inch- (1.3-mm-) thick stainless steel. Minimum 18 gauge stainless steel tubing.
3. Mounting Flanges: Stainless steel flanges designed for concealed fasteners.
4. Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

B. Folding Shower Seat

1. Bradley, Model 9569.
2. Configuration: L-shaped seat.
3. Seat: Phenolic or polymeric composite of slat-type or one-piece construction in color as selected by Architect, 0.05-inch (1.3-mm) minimum nominal thickness; with single-piece, pan-type construction and edge seams welded and ground smooth.
4. Mounting Mechanism: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
5. Provide clear sealant in fastener penetrations.

C. Shower Curtain and Hooks:

1. Bradley, Model 9537 curtain with 9536 hooks.
2. Description: White antimicrobial shower curtain. 9-oz nylon-reinforced PVC vinyl fabric with top edge hemmed. Aluminum grommets on 6" centers.
3. Thickness: 0.14 inch.
4. Dimensions: Shower width plus six inches x 72 inches.
5. Curtain Hooks: stainless steel spring wire with snap fastener for 1-1/4-inch diameter curtain rods. Provide number of curtain hooks per shower enclosure based on manufacturer's recommendation.

D. Robe Hook (mounted above changing bench):

1. Bradley, Model 9943.
2. Description: 3 hook unit.
3. Material and Finish: Stainless steel, No. 4 finish (satin).

2.4 WARM-AIR DRYERS

- ### A. Basis-of-Design Product: Subject to compliance with requirements, provide Bradley Corporation; Model Number 2902-287400 Aerix Surface-Mounted Automatic electric hand dryer or comparable ADA-compliant product.

B. Warm-Air Dryer:

1. Mounting: Surface to meet ADA.

2. Operation: Touch-free infra-red activation.
 - a. Operation Time: 60 seconds.
3. Cover Material and Finish: No.4 Satin finish, vertical grain.
4. Electrical Requirements: 120V AC, 50-60 Hz.

2.5 CHILDCARE ACCESSORIES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Bradley; Model 962-11 or an equal product by one of the following:
 1. American Specialties, Inc.
 2. Brocar Products, Inc.
 3. Bobrick
 4. Or approved equal.
- B. Diaper-Changing Station:
 1. Description: Horizontal unit that opens by folding down from stored position and with child-protection strap.
 - a. Engineered to support a minimum of 250-lb (113-kg) static load when opened.
 - b. Units exceed static load requirements called out by ASTM Standard F 2285, Standard Consumer Safety Performance Specification for Diaper Changing Stations for Commercial Use.
 2. Mounting: Surface-mounted, with unit projecting not more than 4 inches (100 mm) from wall when closed. Factory-drilled mounting holes and mounting hardware included.
 3. Operation: Concealed pneumatic cylinder providing controlled, slow opening and closing of the changing station bed.
 4. Material and Finish: FDA approved blow molded high-density polyethylene (HDPE) clad in 18 gauge Type 304 stainless steel, brushed finish.
 5. Stainless Steel Liquid Diversion Channel: Prevents liquids that may be present on the changing surface from draining into the wall.
 6. Hinge Mechanism: Reinforced full-length steel-on-steel hinge with integrated steel hook plate.
 7. Changing Surface: Contoured, concave and smooth, 442 sq. in.
 8. Safety Straps: Replaceable, snap-lock, nylon protective holding straps.
 9. Features: No hinge structure exposed on interior or exterior surfaces; two bag hooks; built-in liner dispenser with 25 liner capacity.
 10. Instruction Graphics: Universal molded instruction graphics and safety messages in multiple languages.

2.6 UNDERLAVATORY GUARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Plumberex Specialty Products, Inc.
2. Truebro by IPS Corporation.

B. Underlavatory Guard:

1. Description: Insulating pipe covering for supply and drain piping assemblies that prevent direct contact with and burns from piping; allow service access without removing coverings.
2. Material and Finish: Antimicrobial, molded plastic, white.

2.7 CUSTODIAL ACCESSORIES

A. Utility Shelf with Mop/Broom Holder:

1. Bradley, Model 9983.
2. Description: Shelf with 3 hooks / 3 holders
3. Size: 30 inches long by 8 inches deep.
4. Material and Finish: Not less than nominal 0.05-inch- (1.3-mm-) thick stainless steel, No. 4 finish (satin).

2.8 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 to Department's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Grab Bars: Install to withstand a downward load of at least 250 lbf (1112 N), when tested according to ASTM F446.

END OF SECTION 102800

SECTION 104416
FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.6 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. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide JL Industries, Inc.; a division of the Activar Construction Products Group; Saturn or a comparable product by one of the following:
 - a. Kidde Residential and Commercial Division.
 - b. Larsens Manufacturing Company.
 - c. Potter Roemer LLC.
 - d. Nystrom, Inc.
 - 2. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.
- B. Multipurpose Dry-Chemical Type UL-rated 2A-10B:C five pound nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.

2.3 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or black baked-enamel finish.
- B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
 - 1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
 - a. Orientation: Vertical or Horizontal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

- C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 104416

SECTION 220500

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes the following basic Plumbing materials and methods to compliment other plumbing sections:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Concrete base construction requirements.
 - 3. Escutcheons.
 - 4. Dielectric fittings.
 - 5. Flexible connectors.
 - 6. Mechanical sleeve seals.
 - 7. Tamperproof screws.
 - 8. Pipe cover system.
 - 9. Equipment nameplate data requirements.
 - 10. Nonshrink grout for equipment installations.
 - 11. Field-fabricated metal equipment supports.
 - 12. Installation requirements common to equipment specification sections.
 - 13. Cutting and patching.
 - 14. Touchup painting and finishing.
 - 15. Earthwork.
 - 16. Concrete Work

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The terms "Engineer" and "Architect" used in these specifications are used interchangeably, and refer to the same entities - the design professionals of record.
- G. References to "GC", "General Contractor" shall refer to the .1 Contractor.
- H. References to "HC", "Heating Contractor", "HVAC Contractor", and "Mechanical Contractor" on the drawings depicting the HVAC system work shall refer to the .2 Contractor performing the work of Division 23.
- I. References to "PC", "Plumbing Contractor" shall refer to the .3 Contractor performing the work of Division 22.
- J. References to "EC" and "Electrical Contractor" on the drawings depicting the HVAC system work shall refer to the .4 Contractor performing the work of Divisions 26, 27, and 28.

1.4 SUBMITTALS

- A. Product Data: For dielectric fittings, mechanical sleeve seals, disconnect switches and starters, and firestopping materials.
- B. Shop Drawings: Detail fabrication and installation for metal supports and anchorage for plumbing materials and equipment.
- C. Revise examples below to include specific rooms, restricted space locations, equipment installations, system interfaces, and similar critical work.
- D. Coordination Drawings: Detail major elements, components, and systems of plumbing equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
 - 1. Planned piping layout, including valve and specialty locations and valve-stem movement.
 - 2. Clearances for installing and maintaining insulation.
 - 3. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
 - 4. Equipment and accessory service connections and support details.
 - 5. Exterior wall penetrations.
 - 6. Fire-rated wall and floor penetrations.
 - 7. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
 - 8. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

9. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.

- E. Electronic Files: Provide electronic files of all shop drawings and coordination drawings in AUTOCAD 2006 format or later version. Also provide drawings in a PDF format.

1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
- D. NSF Compliance: All piping, valves, fittings, components and materials installed and exposed to the potable-water supply system shall comply with NSF 14, NSF/ ANSI 61 Annex G and NSF/ ANSI 372 for 0.25% maximum lead content requirements. All Plastic piping and components shall be marked with "NSF-pw."
- E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- F. Piping materials shall bear proper labels, stamps, or other markings that identify the specified manufacturer, place of origin, quality control tracking identification, date and testing agency approvals.
- G. Cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF International.
- H. Mechanical (Press-Fit) Pressure Seal Joint Fitting Installations: Qualify the equipment, processes and operators according to the pipe fitting system Manufacturer requirements and recommendations.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.

- B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.
- C. Protect flanges, fittings, and piping specialties from moisture and dirt.
- D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION, SEQUENCING AND SCHEDULING

- A. Coordinate plumbing equipment installation with other building components.
- B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for plumbing installations.
- C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.
- D. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.
- E. Coordinate requirements for access panels and doors if plumbing items requiring access are concealed behind finished surfaces.
- F. Coordinate connection of plumbing systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1. Dielectric Unions:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Co.
 - c. Eclipse, Inc.; Rockford-Eclipse Div.
 - d. EpcO Sales Inc.
 - e. Hart Industries International, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.
 - 2. Dielectric Couplings:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.

3. Dielectric Nipples:
 - a. Grinnell Corp.; Grinnell Supply Sales Co.
 - b. Perfection Corp.
 - c. Victaulic Co. of America.
4. Fire-Stopping:
 - a. "Dow Corning Fire Stop Sealant"; Dow Corning Corp.
 - b. "3M Fire Barrier Caulk CP-25"; Electrical Products Div./3M.
 - c. "RTV 7403"; General Electric Co.
 - d. "Fyre Putty"; Standard Oil Engineered Materials Co.
5. Fire-Stop Pipe Sleeves:
 - a. Pipe Shields, Inc.
 - b. Pro-Set, Inc.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAgl, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining Plastic Piping:
 1. ABS Piping: ASTM D 2235.
 2. CPVC Piping: ASTM F 493.
 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 4. PVC to ABS Piping Transition: ASTM D 3138.

2.4 DIELECTRIC FITTINGS

- A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.
- B. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.
- C. Insulating Material: Suitable for system fluid, pressure, and temperature.
- D. Revise pressure ratings and temperatures in five paragraphs below as required or add other options for specific applications.
- E. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.5 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Stainless steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 SLEEVES

A. Sleeves: The following materials are for wall, floor, slab, and roof penetrations:

1. Steel Sheet Metal: 0.0239-inch minimum thickness, galvanized, round tube closed with welded longitudinal joint.
2. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends.
3. Sleeve in subparagraph below is available with many end variations.
4. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.7 ESCUTCHEONS

A. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type if required to conceal protruding fittings and sleeves.

1. ID: Closely fit around pipe, tube, and insulation of insulated piping.
2. OD: Completely cover opening.
3. Cast Brass: One piece, with set screw.
 - a. Finish: Rough brass.
 - b. Finish: Polished chrome-plate.
4. Cast Brass: Split casting, with concealed hinge and set screw.
 - a. Finish: Rough brass.
 - b. Finish: Polished chrome-plate.
5. Stamped Steel: One piece, with set screw and chrome-plated finish.
6. Stamped Steel: One piece, with spring clips and chrome-plated finish.
7. Stamped Steel: Split plate, with concealed hinge, set screw, and chrome-plated finish.
8. Stamped Steel: Split plate, with concealed hinge, spring clips, and chrome-plated finish.
9. Stamped Steel: Split plate, with exposed-rivet hinge, set screw, and chrome-plated finish.
10. Stamped Steel: Split plate, with exposed-rivet hinge, spring clips, and chrome-plated finish.
11. Cast-Iron Floor Plate: One-piece casting.

2.8 GROUT

A. Non-shrink, Nonmetallic Grout: ASTM C 1107, Grade B.

1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

2.9 FIRE-STOPPING

- A. Fire-Resistant Sealant: Provide one-part elastomeric sealant formulated for use in a through-penetration fire-stop system for filling openings around duct and piping penetrations through walls and floors, having fire-resistance ratings equal to or greater than adjacent construction and as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc.
- B. Fire-Stop Pipe Sleeves: As an option, and if approved by local codes, prefabricated fire-stop pipe sleeves also may be utilized. Pipe sleeves shall be UL Listed and tested in accordance with ASTM E 814. Sleeves shall be adjustable and shall be filled with ceramic fiber material to provide insulation and fire stopping. Sleeves shall provide a 2-hour fire rating.

2.10 INTEGRAL MOTOR STARTERS AND DISCONNECT SWITCHES

- A. Throughout this specification, where mechanical equipment is specified to be factory furnished with disconnect switches and/or motor starters, the equipment provided shall be furnished with combination full voltage magnetic starters and fused disconnect switches. All starters and disconnect switches provided under Division 22 shall conform to applicable Division 26 specifications.
- B. The short circuit rating of starters, switches, and equipment mounted power distribution and control panels shall be no less than 10,000 AIC, or as elsewhere specified in Division 22 or 26, whichever value is highest.
- C. Starters shall have three (3) current overload relays and low-voltage release. Starters shall be furnished with "Hand-Off-Automatic" switch, red-run light, overload reset, a full set of extra interlocks with provisions for additional sets and a control transformer of ample capacity with 120 volt fused control circuit.
- D. Starter enclosure shall be NEMA 1 (or NEMA 3R where exposed to weather).
- E. Where single phase motors are designated to be factory furnished with disconnect switches, the motor shall incorporate a NEMA KS 1, Type HD disconnect switch, with lockable handle.
- F. Disconnect switches shall be horsepower rated to match the horsepower of the motors plus 1.15 service factors.

2.11 TAMPERPROOF SCREWS

- A. All screws on plumbing equipment throughout the building, which are exposed to view and which are installed under this Contract, shall be institutional tamperproof type, including screws on exterior surfaces of floor drains, water coolers, fixtures and fixture trim, and other similar equipment. Phillips head screws are not regarded as tamperproof and are not acceptable. Spanner head, Allen head, or Holt head screws will be acceptable. All screw heads shall be of the same type and all finishes shall match the equipment in which they are installed.

2.12 CONCRETE HOUSEKEEPING BASES

- A. Indoor Concrete Housekeeping Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions.
1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 2. Bases shall be 4" high, unless otherwise noted.
 3. 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 the base.
 4. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 6. Install anchor bolts to elevations required for proper attachment to supported equipment. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and the specified piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.

- K. Install only specified and approved metallic water supply, drainage and vent piping in designated return air plenum areas or spaces. No PVC, CPVC piping or associated plastic piping with "Plenum Wrap" insulation will be accepted or approved for designated plenum area installations.
- L. Install only specified metallic drainage piping and fittings for all sanitary, waste and vent piping systems located within in Mechanical Equipment areas, Food Service, Kitchen, Dishwashing and Laundry areas where the waste discharge may potentially exceed 135 degrees F or more.
- M. Install condensate drainage piping from equipment or drain pans at a minimum slope of 1 percent downward in direction of gravity flow for all piping towards the drain termination. Install cleanouts at accessible locations to provide for adequate maintenance, cleaning and inspection of drainage lines.
- N. Select system components with pressure rating equal to or greater than system operating pressure.
- O. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:
 - 1. Uninsulated Piping Wall Escutcheons: Cast brass or stamped steel, with set screw.
 - 2. Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.
 - 3. Insulated Piping: Cast brass or stamped steel; with concealed hinge, spring clips, and chrome-plated finish.
 - 4. Piping in Utility Areas: Cast brass or stamped steel, with set-screw or spring clips.
- P. Sleeves are not required for core-drilled holes.
- Q. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 - 1) Seal space outside of sleeve fittings with grout.

4. Use Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant, unless otherwise indicated
 5. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 6. Install steel pipe for sleeves smaller than 6 inches in diameter.
 7. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 8. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
 9. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 10. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- R. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.
- S. Verify final equipment locations for roughing-in.
- T. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and as specifically required in individual piping systems specifications.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 4. PVC Nonpressure Piping: Join according to ASTM D 2855.
 5. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 3. Edit dielectric connection types in two subparagraphs below for each fluid.
 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

- E. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.
- F. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Professional.

3.5 PAINTING – TOUCH-UP AND FINISHING

- A. Refer to Division 09 Section "Painting - Exterior and Interior" for paint materials, surface preparation, and application of paint.
- B. Refer to Division 22 Section "Identification for Plumbing Piping and Equipment" for plumbing color schemes.
- C. Paint plumbing systems, equipment, and components as specified.
- D. Apply paint to exposed piping according to the following, unless otherwise indicated:
 - 1. Interior, Ferrous Piping: Use semi-gloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
 - 2. Interior, Galvanized-Steel Piping: Use semi-gloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
 - 3. Interior, Ferrous Supports: Use semi-gloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
 - 4. Exterior, Ferrous Piping: Use semi-gloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.
 - 5. Exterior, Galvanized-Steel Piping: Use semi-gloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
 - 6. Exterior, Galvanized-Steel Supports: Use semi-gloss, acrylic-enamel finish. Include two finish coats over galvanized metal primer.
- E. Do not paint piping specialties with factory-applied finish.
- F. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.8 GROUTING

- A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

3.9 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for plumbing installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair cut surfaces to match adjacent surfaces.

3.10 EARTHWORK

- A. Perform all necessary excavating of widths and to depths required for the installation of all underground lines, materials, and equipment installed under this Contract, and including all backfilling, interior and exterior, except as otherwise shown or specified. The proposal shall

include all excavation that may be necessary to complete the project, including any rock that may be encountered and the furnishing of proper backfill material where necessary.

- B. Include all necessary excavation and backfilling for the removal of existing utilities, equipment, and structures encountered under this Contract.
- C. The excavation shall be kept safe at all times. Shoring and sheathing shall be used where necessary. Additional shoring and sheathing shall be furnished and installed to safeguard the work. Shoring and sheathing shall be provided in strict accordance with all applicable federal, State, county and local ordinances and regulations. The excavation shall be kept free of water at all times. Excavation below required depth shall be refilled with sand or gravel firmly compacted. Provide bell holes to insure uniform bearing of all pipe. Depth of excavation for all plumbing lines shall be sufficient to install lines at an even grade.
- D. All excess excavated materials shall be disposed of at points on the site designated by the Professional, or off the site at an approved land fill area. The number of points at which this Contractor will be permitted to work, and the length of continuous open trench that will be permitted, will be governed by the Professional. When using local streets for disposal of excavated materials, the Contractor must obtain approval of his trucking route (between the building site and the disposal site) from all local authorities and other governing agencies, prior to the disposal of excavated materials.
- E. To protect persons from injury and to avoid property damage, adequate barricades, construction signs, red lanterns, audible and visual warning signals, guards, etc. shall be placed and maintained during the progress of the construction work and until it is safe for traffic use. Flag persons shall be utilized where required to properly control traffic and provide traffic safety. Rules and regulations of the local, federal, county, and State authorities respecting safety provisions shall be observed.
- F. Excavation for pipe laying and other work shall be conducted in a manner to cause the least interruption to traffic. Where traffic must cross open trenches or open excavated areas, this Contractor shall provide suitable bridges. Where existing concrete or pavement is encountered during the pipe laying operation, openings shall be made using the "saw cut" method.
- G. Adequate protection shall be provided for all existing or new structures, services, or utilities encountered in the excavation. The protection shall include bracing, sheathing, supports, and other materials as required to maintain grade and alignment and to provide proper mechanical strength. Any structures, services, or utilities damaged by the work of this Contractor shall be promptly repaired and placed in same condition as they originally were prior to such damage, by the Contractor at no additional cost to the Department.
- H. Trenches shall be of sufficient width to provide a free working space on each side of the pipe, of not over 1/3 of the nominal diameter of the pipe and never less than 4", according to the size of the pipe and the character of the ground, but in every case, there shall be sufficient space between the pipe and the sides of the trench to thoroughly ram the backfilling around the pipe to secure tight joints. In earth excavation the trench shall be carried to the invert of the pipe. Where rock excavation is encountered, the trench shall be carried to a point 6" below the invert of the pipe. No pipe shall be bedded directly upon rock, but shall be cushioned by a 6" layer of selected crushed stone or gravel.

- I. Include any required pumping, bailing, or drainage of water that may accumulate or be found in trenches or other excavated areas. Trenches and excavated areas shall be kept free from water until the material in the joints has sufficiently hardened. No pipe or masonry shall be laid in water and new laid masonry or pipe shall be protected so that no flood or surface water may enter same. Protection shall be provided in a manner satisfactory to the Professional.
- J. After pipe lines and other equipment have been installed, tested, and inspected, the excavation shall be backfilled by this Contractor with the best carefully selected materials, free from stones, large pebbles, hard lumps, frozen earth, or debris. No trenches or excavation shall be backfilled until lines and other equipment have been inspected, and approved by the Professional. Additional materials required for backfilling in excess of that obtained by excavating shall be provided by the Contractor and shall be of materials approved by the Professional. Where necessary, backfill shall be hauled from off-site locations at no additional cost to the Department. No backfilling shall be done until systems are tested in the presence of and approved by the Professional. Compaction under roadways, streets, avenues, parking areas, and other similar paved areas and within the building under slab on grade areas, shall be compacted to a minimum density equal to 95% of the maximum dry density as determined by the Modified Proctor Test (ASTM D1557). Compaction under walkways shall be compacted to a minimum density equal to 92% of the maximum dry density as determined by the Modified Proctor Test (ASTM D1557). Compaction under lawn or unpaved areas shall be compacted to a minimum density equal to 85% of the maximum dry density as determined by the Modified Proctor Test (ASTM D1557). All tests, including all costs of tests, shall be included under the Plumbing Contract.
- K. The backfilling of trenches and excavated areas shall be placed in horizontal layers not exceeding 6" in thickness with each layer thoroughly consolidated and compressed with pneumatic rammers. The backfilling shall be thoroughly tamped and rammed underneath and around the pipe and fittings. No backfilling shall be done until all undermined earth or pavement shall have been broken down and the sides of the excavation made vertical or inclined outward. The filling under, around, and for a distance of at least 1'-0" over all lines and other equipment shall be selected excavated materials with no particles larger than 2" and with each layer thoroughly compacted as specified above. The remainder of the fill over all lines and other equipment to the surface of the adjoining ground shall be ordinary approved excavated materials placed in 6" layers and thoroughly compacted as herein specified.
- L. Restore the surface of all excavations to their original condition. This shall include paved or unpaved streets, sidewalks, curbs, steps, roadways, driveways, avenues, parking areas, or turf. Include all necessary raking, fertilizing, seeding, rough and finish grading. Coordinate all of the restoration work with the extent of work included under the General Contract. Restore all surfaces to the satisfaction of the Professional. Existing trees, shrubs, or turf damaged under this Contract shall be replaced to the satisfaction of the Professional.
- M. Any settling or washing out of earth after the initial installation shall be corrected by this Contractor.
- N. As the work progresses, record on the drawings all changes and deviations from the Contract Drawings. Measurements shall include elevations and sufficient offset measurements from buildings to definitely locate all lines and other equipment installed or constructed under this Contract. Two prints of the marked drawings shall be delivered to the Professional before final acceptance.

3.11 CONCRETE WORK

- A. Furnish and install concrete work for all work included under this Contract. Concrete bases shall be constructed for all equipment which would normally be set on the floor, except where shown or specified otherwise. Bases and forms shall be of suitable dimensions for all equipment, or of sizes herein indicated. Include all concrete as required for patchwork.
- B. Interior bases shall be 4" high except where the contract drawings or specifications exceed this height. Interior bases shall be reinforced with 6 x 6 x No. 10 gauge wire mesh and anchored through floor construction with 3/4" diameter bolts and rods. Exterior bases shall be reinforced as noted. Exterior bases shall be of thicknesses noted. Anchor bolts for equipment shall be placed in base before equipment is set. Bases shall be 4" longer each direction, than the equipment being installed, except where the Contract Documents specifically exceed this dimension.
- C. Laboratory tests and samples are not required, unless, in the opinion of the Professional, the concrete is not satisfactory, then the Contractor shall have a test and/or tests as directed. All costs for tests, samples, etc., shall be included in this Contract.
- D. All materials used for plain and reinforced concrete and the measuring, mixing, handling, placing and curing shall conform to current specifications of the American Concrete Institute (ACI 304 and ACI 318). Cement shall be normal Portland cement, Type I or Type II, conforming to ASTM Designation C-150.
- E. Aggregates shall consist of sand of approved quality, crushed stone, and washed gravel, conforming to ASTM Standard Specification Designation C-33, and shall be supplied from a source approved by the Professional. The maximum size of the aggregate shall be no larger than 1/5 of the narrowest dimensions between forms of the members for which the concrete is to be used; no larger than 3/4 of the minimum clear spacing between reinforcing bars. All water for concrete shall be clean and free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substances.
- F. Slag in any form will not be permitted as an aggregate. Proportions shall be in accordance with American Concrete Institute Standard "Recommended Practice for the Design of Concrete Mixes ACI 211.1." The 28-day minimum compressive strength shall be 3,000 psi, except for precast concrete products as shown or specified.
- G. Metal reinforcement shall be deformed steel bars or cold-drawn steel wire, or fabricated forms of these materials, as required by the drawings, or the specifications, or both. All bars shall be deformed, intermediate grade, new billet steel. These materials shall conform in quality to Standard Specifications of the American Society for Testing Materials of the following applicable titles and serial designations:

Bars

Billet-Steel Bars for Concrete Reinforcement -----A 615
Rail-Steel Bars for Concrete Reinforcement -----A 616

Wire

Cold-Drawn Steel Wire for Concrete Reinforcement ----- A 82

Fabricated Materials

Fabricated Steel Bar or Rod Mats for Concrete Reinforcement -----A 184

Welded Steel Wire Fabric for Concrete Reinforcement -----A 185

- H. Forms shall be of steel or wood and shall conform to the shape, lines, grades, and dimensions of the concrete as required. Forms shall be sufficiently tight to prevent leakage of mortar, and shall be properly braced and tied together so as to maintain the desired position and shape during and after placing concrete. Forms shall be removed in such a manner as to assure the complete safety of the structure. All exposed corners or edges shall be chamfered. All burrs, fins, irregularities of forming, or spillage, shall be removed and the surface float or trowel finished to a smooth, straight surface.
- I. For waterproofing concrete, concrete shall be integrally waterproofed with Aquabar additive, or approved equal.
- J. For water stopping, water stops of plastic, as manufactured by Thunderline Corporation, Ryerson, Greenstreak, Vulcan Products, or approved equal, shall be installed in all concrete joints and between pours.
- K. Include all concrete required for piping installed in trenches at building footer locations. The Contractor shall locate underground piping within limits of the structure, in coordination with the General Contractor, to assure no footing will be undermined by trenching. Any piping trench shall be located so the trench edge is not closer to any structural footing than 1-1/2 times the vertical distance from trench bottom to footing bottom. In any event this condition is not met, it shall be the responsibility of the Contractor installing the piping to fill the trench with lean concrete, after piping is installed, to an elevation where the surface of the concrete shall not be closer to any footing than twice the vertical distance between footing bottom and the closest edges of the concrete poured in the trench. Where excavations for piping extend under and perpendicular to a wall footing, the Contractor installing the piping shall fill the trench with concrete solidly to bottom of footing for a trench length of 3'-0" beyond each wall face.

END OF SECTION

SECTION 220513

COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Basic Requirements: For Factory-Installed and Field-Installed Motors.

- B. Related Sections:

- 1. Division 22 Sections for application of motors and reference to specific motor requirements for motor-driven equipment.

1.3 SUBMITTALS

- A. Product Data:

- 1. Submit "Letter of Conformance" in accordance with Section 01330 indicating specified items selected for use in project.
 - 2. Show nameplate data and ratings; characteristics; mounting arrangements; size and location of winding termination lugs, conduit entry, and grounding lug; and coatings.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.

- B. Efficiency: Conform to requirements of the Federal Energy Policy Act of 1992 (EPACT) for energy efficiency ratings of motors.

- C. Listing and Labeling: Provide motors specified in this Section that are listed and labeled.

- 1. Terms "Listed and Labeled": As defined in the National Electrical Code, Article 100.

1.5 WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Client Agency of other rights Client Agency may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Manufacturer's Extended Warranty on Motors Used With Variable-Frequency Controllers: Written warranty, signed by manufacturer agreeing to repair or replace motor, including labor.
 - 1. Warranty Period: Manufacturer's standard, but not less than three (3) years after date of Substantial Completion.

PART 2 - PRODUCTS

2.1 BASIC MOTOR REQUIREMENTS

- A. Basic requirements apply to mechanical equipment motors, unless otherwise indicated.
- B. Motors 1/2 HP and Larger: Polyphase.
- C. Motors Smaller than 1/2 HP: Single phase.
- D. Frequency Rating: 60 Hz.
- E. Voltage Rating: Determined by voltage of circuit to which motor is connected.
- F. Service Factor: According to NEMA MG 1, general purpose continuous duty, design type "B."
- G. Capacity and Torque Characteristics: Rated for continuous duty and sufficient to start, accelerate, and operate connected loads at designated speeds, in indicated environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
- H. Enclosure: Open dripproof, unless otherwise indicated.

2.2 POLYPHASE MOTORS

- A. Description: NEMA MG 1, medium induction motor.
 - 1. Design Characteristics: NEMA MG 1, Design B, unless otherwise indicated.
 - 2. Energy-Efficient Design: Where indicated.
 - 3. Stator: Copper windings, unless otherwise indicated. Multispeed motors have separate winding for each speed.
 - 4. Rotor: Squirrel cage, unless otherwise indicated.
 - 5. Bearings: Double-shielded, prelubricated ball bearings suitable for radial and thrust loading.

6. Temperature Rise: Match insulation rating, unless otherwise indicated.
 7. Insulation: Class F, unless otherwise indicated.
- B. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for indicated controller, with required motor leads brought to motor terminal box to suit control method.
- C. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
1. Design Characteristics: NEMA MG 1, Part 31.
 2. Temperature Rise: Match rating for Class B insulation.
 3. Insulation: Class F.
 4. No limitation on cable run between motor and variable-frequency controller.
 5. Thermal Protection: Where indicated, conform to NEMA MG 1 requirements for thermally protected motors.
- D. Source Quality Control: Perform the following routine tests according to NEMA MG 1:
1. Measurement of winding resistance.
 2. No-load readings of current and speed at rated voltage and frequency.
 3. Locked rotor current at rated frequency.
 4. High-potential test.
 5. Alignment.

2.3 SINGLE-PHASE MOTORS

- A. Type: As indicated or selected by manufacturer from one of the following, to suit starting torque and other requirements of specific motor application.
1. Permanent-split capacitor.
 2. Split-phase start, capacitor run.
 3. Capacitor start, capacitor run.
- B. Shaded-Pole Motors: Do not use, unless motors are smaller than 1/20 hp.
- C. Thermal Protection: Where indicated or required, internal protection automatically opens power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal protection device automatically resets when motor temperature returns to normal range, unless otherwise indicated.
- D. Bearings: Ball-bearing type for belt-connected motors and other motors with high radial forces on motor shaft. Sealed, prelubricated sleeve bearings for other single-phase motors.

PART 3 - EXECUTION

3.1 ADJUSTING

- A. Use adjustable motor mounting bases for belt-driven motors.

- B. Align pulleys and install belts.
- C. Tension according to manufacturer's written instructions.

END OF SECTION

SECTION 220517

SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 STACK-SLEEVE FITTINGS

- A. Stack-sleeve fittings in this article can be used in concrete floor and roof slabs, but are without seepage holes; therefore, they cannot be used as replacements for floor drains. Using grout, fill the annular space between fitting and slab opening. These fittings are available in NPS 1-1/2 to NPS 12.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1. Smith, Jay R. Mfg. Co.
 - 2. Zurn Industries, LLC.
- C. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

- A. Sleeve-seal systems in this article are used for piping penetrations in slabs-on-grade and below grade in exterior walls. These systems are available for NPS 1/2 to NPS 48 piping.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1. Advance Products & Systems, Inc.
 - 2. Metraflex Company (The).
 - 3. Proco Products, Inc.
- C. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Stainless steel.
 - 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

- A. Sleeve-seal fittings in this article are used for piping penetrations in slabs-on-grade and in exterior walls. These fittings are made to match piping OD, so they must be selected to match the penetrating piping size. They are available for NPS 1/2 to NPS 6 piping.

- B. Manufacturers: Subject to compliance with requirements, provide products by the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. HOLDRITE.
- C. Description: Manufactured plastic, sleeve-type, water-stop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber water-stop collar with center opening to match piping OD.

2.5 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for fire stopping specified in Division 07.

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 5. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for fire stopping specified in Division 07.

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves or Sleeve-seal fittings.
 - b. Piping NPS 6 and Larger: Cast-iron wall sleeves.
2. Exterior Concrete Walls below Grade:
 - a. Piping All Sizes: Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
3. Concrete Slabs-on-Grade:
 - a. Piping All Sizes: Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
4. Concrete Slabs above Grade:
 - a. Piping All Sizes: Galvanized-steel-pipe sleeves.
5. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION

SECTION 220518

ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish; or one-piece, stamped-steel type.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish; or one-piece, stamped-steel type.
 - f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated or rough-brass finish; one-piece, stamped-steel type.
 - g. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated rough-brass finish; or one-piece, stamped-steel type.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor-plate type.

3.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION

SECTION 220519

METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes meters and gages for Plumbing systems.
- B. Related Sections include the following:
 - 1. Plumbing equipment Sections that specify meters and gages as part of factory-fabricated equipment.

1.3 SUBMITTALS

- A. Product Data: Include scale range, ratings, and calibrated performance curves for each meter, gage, fitting, specialty, and accessory specified.
- B. Shop Drawings: Include schedule indicating manufacturer's number, scale range, fittings, and location for each meter and gage.
- C. Product Certificates: Signed by manufacturers of meters and gages certifying accuracies under specified operating conditions and compliance with specified requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1. Liquid-in-Glass Thermometers:
 - a. Dresser Industries, Inc.; Instrument Div.; Weksler Instruments Operating Unit.
 - b. Ernst Gage Co.
 - c. Miljoco Corp.
 - d. Terrice: H. O. Terrice Co.

- e. Weiss Instruments, Inc.
2. Pressure Gages:
 - a. Dresser Industries, Inc.; Instrument Div.; Ashcroft Commercial Sales Operation.
 - b. Dresser Industries, Inc.; Instrument Div.; Weksler Instruments Operating Unit.
 - c. Ernst Gage Co.
 - d. Miljoco Corp.
 - e. Terice: H. O. Terice Co.
 - f. Weiss Instruments, Inc.
 3. Test Plugs:
 - a. Flow Design, Inc.
 - b. MG Piping Products Co.
 - c. National Meter.
 - d. Peterson Equipment Co., Inc.
 - e. Sisco Manufacturing Co.
 - f. Terice: H. O. Terice Co.
 - g. Watts Industries, Inc.; Water Products Div.

2.2 THERMOMETERS, GENERAL

- A. Scale Range: Temperature ranges for services listed are as follows:
 1. Domestic Hot Water: 30 to 300 deg F, with 2-degree scale divisions.
 2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions.
- B. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

2.3 LIQUID-IN-GLASS THERMOMETERS

- A. Description: ASTM E 1.
- B. Case: Die cast and aluminum finished in baked-epoxy enamel, glass front, spring secured, 9 inches long.
- C. Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.
- D. Tube: Red or blue reading, inorganic liquid-filled with magnifying lens.
- E. Scale: Satin-faced nonreflective aluminum with permanently etched markings.
- F. Stem: Copper-plated steel, aluminum, or brass for separable socket; of length to suit installation.

2.4 SEPARABLE SOCKETS

- A. Description: Fitting with protective socket for installation in threaded pipe fitting to hold fixed thermometer stem.
 - 1. Material: Brass, for use in copper piping.
 - 2. Material: Stainless steel, for use in steel piping.
 - 3. Extension-Neck Length: Nominal thickness of 2 inches, but not less than thickness of insulation. Omit extension neck for sockets for piping not insulated.
 - 4. Insertion Length: To extend 2 inches into pipe.
 - 5. Cap: Threaded, with chain permanently fastened to socket.
 - 6. Heat-Transfer Fluid: Oil or graphite.

2.5 THERMOMETER WELLS

- A. Description: Fitting with protective well for installation in threaded pipe fitting to hold test thermometer.
 - 1. Material: Brass, for use in copper piping.
 - 2. Material: Stainless steel, for use in steel piping.
 - 3. Extension-Neck Length: Nominal thickness of 2 inches, but not less than thickness of insulation. Omit extension neck for wells for piping not insulated.
 - 4. Insertion Length: To extend 2 inches into pipe.
 - 5. Cap: Threaded, with chain permanently fastened to socket.
 - 6. Heat-Transfer Fluid: Oil or graphite.

2.6 PRESSURE GAGES

- A. Description: ASME B40.1, phosphor-bronze bourdon-tube type with bottom connection; dry type, unless liquid-filled-case type is indicated.
- B. Case: Drawn steel, brass, or aluminum with 4-1/2-inch-diameter, glass lens.
- C. Connector: Brass, NPS 1/4.
- D. Scale: White-coated aluminum with permanently etched markings.
- E. Accuracy: Grade A, plus or minus 1 percent of middle 50 percent of scale.
- F. Range: Comply with the following:
 - 1. Fluids under Pressure: Two times the operating pressure.
 - 2. Vacuum: 30 inches Hg of vacuum to two times the operating pressure.

2.7 PRESSURE-GAGE FITTINGS

- A. Valves: NPS 1/4 brass or stainless-steel needle type.

- B. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

2.8 TEST PLUGS

- A. Description: Nickel-plated, brass-body test plug in NPS 1/2 fitting.
- B. Body: Length as required to extend beyond insulation.
- C. Pressure Rating: 500 psig minimum.
- D. Core Inserts: Two self-sealing valves, suitable for inserting 1/8-inch OD probe from dial-type thermometer or pressure gage.
- E. Core Material for Air, Water, Oil, and Gas: 20 to 200 deg F, chlorosulfonated polyethylene synthetic rubber.
- F. Test-Plug Cap: Gasketed and threaded cap, with retention chain or strap.
- G. Test Kit: Pressure gage and adapter with probe, two bimetal dial thermometers, and carrying case.
 - 1. Pressure Gage and Thermometer Ranges: Approximately two times the system's operating conditions.

PART 3 - EXECUTION

3.1 METER AND GAGE INSTALLATION, GENERAL

- A. Install meters, gages, and accessories according to manufacturer's written instructions for applications where used.

3.2 THERMOMETER INSTALLATION

- A. Install thermometers and adjust vertical and tilted positions.
- B. Install in the following locations:
 - 1. Inlet and outlet of each gas fired gas water heaters.
 - 2. Elsewhere as indicated on the drawings.
- C. Install separable sockets in vertical position in piping tees where fixed thermometers are indicated.
 - 1. Install with socket extending a minimum of 2 inches into fluid.
 - 2. Fill sockets with oil or graphite and secure caps.

- D. Install thermometer wells in vertical position in piping tees where test thermometers are indicated.
 - 1. Install with stem extending a minimum of 2 inches into fluid.
 - 2. Fill wells with oil or graphite and secure caps.

3.3 PRESSURE-GAGE INSTALLATION

- A. Install pressure gages in piping tees with pressure-gage valve located on pipe at most readable position.
- B. Install dry-type pressure gages in the following locations:
 - 1. Building water -service entrance.
 - 2. Elsewhere as indicated on the drawings.
- C. Install liquid-filled-type pressure gages at suction and discharge of each pump. Provide compound type liquid-filled gauges on the suction side of pumps.
- D. Install pressure-gage needle valve and snubber in piping to pressure gages.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:
 - 1. Install meters and gages adjacent to machines and equipment to allow service and maintenance.

3.5 ADJUSTING AND CLEANING

- A. Calibrate meters according to manufacturer's written instructions, after installation.
- B. Adjust faces of meters and gages to proper angle for best visibility.
- C. Clean windows of meters and gages and clean factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION

SECTION 220523
PLUMBING VALVES

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUBMITTALS

- A. **Product Data:** For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.3 QUALITY ASSURANCE

- A. ASME B31.9 in paragraph below should cover piping systems in Part 3 "Valve Applications" Article up to 125 psig (860 kPa). Higher-pressure systems are covered by ASME B31.1. Domestic water, sanitary waste, and storm drainage piping are covered by plumbing codes, but valves in this Section are suitable for those applications.
- B. **ASME Compliance:** ASME B31.1 for power piping valves and ASME B31.9 for building services piping valves.
- C. **NSF Compliance:** NSF 61 Annex G and NSF 372 for valve materials for potable-water service. "Lead Free" Compliance for all valves, fittings, components and materials installed in the potable-water supply system shall meet the requirement of 0.25% maximum lead content.
- D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- E. **Valve Pressure-Temperature Ratings:** Not less than indicated and as required for system pressures and temperatures.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.

3. Set ball open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
1. Maintain valve end protection.
 2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
1. Ball Valves:
 - a. Conbraco Industries, Inc.; Apollo Division.
 - b. Milwaukee Valve Company, Inc.
 - c. Watts, Inc.

2.2 BASIC, COMMON FEATURES

- A. Pressure and Temperature Ratings: As indicated in the "Application Schedule" of Part 3 of this Section and as required to suit system pressures and temperatures.
- B. Sizes: Same size as upstream pipe, unless otherwise indicated.
- C. Operators: Use specified operators and hand wheels, except provide the following special operator features:
1. Lever Handles: For quarter-turn valves.
- D. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.
- E. Flanges: ASME B16.1 for cast iron, ASME B16.5 for steel, and ASME B16.24 for bronze valves.

2.3 BALL VALVES

- A. Ball Valves, 4 Inches and Smaller: MSS SP-110, Class 150, 600-psi CWP, ASTM B 584 bronze body and bonnet, 2-piece construction; full port; stainless steel ball and stem; teflon seats and seals; threaded or soldered end connections:

1. Operator: Vinyl-covered steel lever handle.
2. Stem Extension: For valves installed in insulated piping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
 1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above center of pipe.
- E. Install valves in position to allow full stem movement.
- F. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
- G. Install check valves for proper direction of flow and as follows:
 1. Swing Check Valves: In horizontal position with hinge pin level.

3.3 FLANGED CONNECTIONS

- A. Align flange surfaces parallel.
- B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

3.4 APPLICATION SCHEDULE

- A. General Application: Use ball valves for shutoff duty and throttling duty. Refer to piping system Specification Sections for specific valve applications and arrangements.
- B. Domestic Water Systems: Use the following valve types:
 - 1. Ball Valves: Class 150, 600-psi CWP, with stem extension.

3.5 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION

SECTION 220529

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes the following hangers and supports for plumbing system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Pipe stands.
 - 7. Pipe positioning systems.
 - 8. Equipment supports.
- B. Related Sections include the following:
 - 1. Division 22 Section "Pipe Expansion Fittings and Loops" for pipe guides and anchors.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Thermal-hanger shield inserts.
 - 3. Pipe positioning systems.
 - 4. Powder-Actuated Fastener System
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers. Include Product Data for components.
 - 2. Metal framing systems. Include Product Data for components.
 - 3. Pipe stands. Include Product Data for components.
 - 4. Equipment supports.
- C. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:
 - 1. Bergen-Power Pipe Supports.
 - 2. Carpenter & Paterson, Inc.
 - 3. Empire Industries, Inc.
 - 4. Grinnell Corp.
 - 5. GS Metals Corp.

6. National Pipe Hanger Corporation.
7. Piping Technology & Products, Inc.
8. Tolco Inc.

- C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers:
 1. B-Line Systems, Inc.; a division of Cooper Industries.
 2. GS Metals Corp.
 3. Power-Strut Div.; Tyco International, Ltd.
 4. Thomas & Betts Corporation.
 5. Tolco Inc.
 6. Unistrut Corp.; Tyco International, Ltd.
- C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Manufacturers:
 1. Carpenter & Paterson, Inc.
 2. Pipe Shields, Inc.
 3. Value Engineered Products, Inc.
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.

- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head.
 - c. Masterset Fastening Systems, Inc.
- B. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers:
 - a. B-Line Systems, Inc.; a division of Cooper Industries.
 - b. Empire Industries, Inc.
 - c. Hilti, Inc.
 - d. ITW Ramset/Red Head.

2.7 PIPE STAND FABRICATION

- A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
 - 1. Manufacturers:
 - a. ERICO/Michigan Hanger Co.
 - b. MIRO Industries.
- C. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.

1. Manufacturers:

- a. MIRO Industries.

- D. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.8 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

B. Manufacturers:

1. C & S Mfg. Corp.
2. HOLDRITE Corp.; Hubbard Enterprises.
3. Samco Stamping, Inc.

2.9 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.10 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 10.
 - 2. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 10, if little or no insulation is required.
 - 3. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 10.
 - 4. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 5. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 10, with steel pipe base stanchion support and cast-iron floor flange.
 - 6. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 10, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
 - 7. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 10, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
 - 8. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 10, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
 - 9. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 10, from single rod if horizontal movement caused by expansion and contraction might occur.
 - 10. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 10, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 10.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 10, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 - 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 - 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 - 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb
 - b. Medium (MSS Type 32): 1500 lb
 - c. Heavy (MSS Type 33): 3000 lb
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.

- L. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- M. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Each trapeze pipe hanger in first paragraph and subparagraphs below requires calculation and detail.
- C. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- D. Each metal framing system in paragraph below requires calculation and detail.
- E. Each fiberglass strut system in first paragraph below requires calculation and detail.
- F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- G. Fastener System Installation:
 - 1. Verify suitability of fasteners in two subparagraphs below for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick.
 - 2. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 3. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- H. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 7 Section "Roof Accessories" for curbs.

- I. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.
- J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- K. Each equipment support in first paragraph below requires calculation and detail.
- L. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- M. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- N. Install lateral bracing with pipe hangers and supports to prevent swaying.
- O. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- P. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- Q. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.

- d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
5. Pipes NPS 8 and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.
- C. All painting shall be done to meet Division 09 requirements.

END OF SECTION

SECTION 220553

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes the following mechanical identification materials and their installation:
 - 1. Equipment nameplates.
 - 2. Equipment markers.
 - 3. Equipment signs.
 - 4. Pipe markers.
 - 5. Valve tags.
 - 6. Valve schedules.
 - 7. Warning tags.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Valve numbering scheme shall be in sequence with each system labeled and identified separately and differently.
- D. Valve Schedules: For each piping system, include a listing of all valves labeled and tagged with a coordinated numbering scheme. Reproduce the schedule on standard-size bond paper. Tabulate valve identification list with tag numbers, system type and abbreviations as shown on the valve tags with the specific building area or room location included. Include special notes and references to specific or special valve variations, functions, operations, maintenance, and emergency services or shutdown procedures. Besides providing a mounted enclosed framed copies in the designated Maintenance Office area, furnish copies for the maintenance manuals.
- E. Equipment Label Schedule: Include a listing of all equipment labeled with the proposed content for each label. Reproduce on standard-size bond paper. Tabulate Equipment identification labels list with numbers, system type and abbreviations as shown on the labels and the specific building area or room location included. Include special notes and references to specific equipment variations, maintenance, operations and emergency services and shutdown. Besides

providing a mounted enclosed framed copies in the Maintenance Office area, furnish copies for the maintenance manuals.

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1. Brimar Industries, Inc.
 - 2. Champion America.
 - 3. Craftmark Pipe Markers.
 - 4. Marking Services Inc.
 - 5. Seton Identification Products.
- B. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
 - 1. Data:
 - a. Manufacturer, product name, model number, and serial number.
 - b. Capacity, operating and power characteristics, and essential data.
 - c. Labels of tested compliances.
 - 2. Location: Accessible and visible.
 - 3. Fasteners: As required to mount on equipment.
- C. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.
 - 1. Terminology: Match schedules as closely as possible.

2. Data:
 - a. Name and plan number.
 - b. Equipment service.
 - c. Design capacity.
 - d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.
 3. Size: 2-1/2 by 4 inches for control devices, and valves; 4-1/2 by 6 inches for equipment.
- D. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
1. Data: Instructions for operation of equipment and for safety procedures.
 2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.
 3. Thickness: 1/16 inch for units up to 20 sq. in. or 8 inches in length, and 1/8 inch for larger units.
 4. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.
- E. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
1. Colors: Comply with ASME A13.1, unless otherwise indicated.
 2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
 3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
 4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
 5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
- F. Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.
- G. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.
- H. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.
- I. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.
1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.

2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

2.2 VALVE TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 1. Brimar Industries, Inc.
 2. Champion America.
 3. Craftmark Pipe Markers.
 4. Marking Services Inc.
 5. Seton Identification Products.
- B. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme. Provide 5/32-inch hole for fastener.
 1. Material: 0.0375-inch- thick stainless steel.
 2. Size: 1-1/2" diameter, unless otherwise indicated.
 3. Valve-Tag Fasteners: Brass Stainless steel beaded chain or S-hook.

2.3 VALVE SCHEDULES

- A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
 2. Frame: Extruded aluminum.
 3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.4 WARNING TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Brimar Industries, Inc.
 2. Champion America.
 3. Craftmark Pipe Markers.
 4. Marking Services Inc.
 5. Seton Identification Products.
- B. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
 1. Size: 3 by 5-1/4 inches minimum.

2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

- A. Products specified are for applications referenced in other Division 15 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

- A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
 1. Fuel-burning units, including water heater units.
 2. Pumps, compressors, and similar motor-driven units.
- B. Install equipment signs with screws or permanent adhesive on or near each major item of plumbing equipment. Locate signs where accessible and visible.
 1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
 3. Include signs for the following general categories of equipment:
 - a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - b. Fuel-burning water heaters.
 - c. Pumps, compressors, and similar motor-driven units.
 - d. Tanks and pressure vessels.
 - e. Strainers, filters, and similar equipment.

3.3 PIPING IDENTIFICATION

- A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

1. Pipes with OD, Including Insulation, Less Than 6 Inches: Pretensioned pipe markers. Use size to ensure a tight fit.
 2. Retain subparagraph above or first subparagraph below.
 3. Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 3/4 inch wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
 4. Pipes with OD, Including Insulation, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.
 5. Retain subparagraph above or below.
 6. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.
- B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior non-concealed locations as follows:
1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and non-accessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; faucets; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:
1. Valve-Tag Size and Shape:
 - a. Cold Water: 1-1/2 inches, round.
 - b. Hot Water: 1-1/2 inches, round.
 - c. LP Gas: 1-1/2 inches, round.
 2. Valve-Tag Color:
 - a. Cold Water: Natural.
 - b. Hot Water: White.
 - c. LP Gas: Yellow.

3. Letter Color:
 - a. Cold Water: Black.
 - b. Hot Water: Black.
 - c. Gas: Black.

3.5 VALVE-SCHEDULE INSTALLATION

- A. Mount valve schedule on wall in accessible location in each major equipment room.

3.6 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

3.7 ADJUSTING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.8 CLEANING

- A. Clean faces of identification devices and glass frames of valve schedules.

END OF SECTION

SECTION 220593

TESTING, ADJUSTING, AND BALANCING OF PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes testing, adjusting, and balancing plumbing systems to produce design objectives, including the following:
 - 1. Reporting results of activities and procedures specified in this Section.
- B. Related Sections include the following:
 - 1. Testing and adjusting requirements unique to particular systems and equipment are included in the Sections that specify those systems and equipment.
 - 2. Field quality-control testing to verify that workmanship quality for system and equipment installation is specified in system and equipment Sections.

1.3 DEFINITIONS

- A. Adjust: To regulate fluid flow rate at the terminal equipment.
- B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.
- C. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- D. Report Forms: Test data sheets for recording test data in logical order.
- E. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- F. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- G. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

- H. Test: A procedure to determine quantitative performance of a system or equipment.
- I. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.

1.4 SUBMITTALS

- A. Quality-Assurance Submittals: Within 30 days from the Contractor's Notice to Proceed, submit 2 copies of evidence that the testing, adjusting, and balancing Agent and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" Article below.
- B. Contract Documents Examination Report: Within 45 days from the Contractor's Notice to Proceed, submit 2 copies of the Contract Documents review report as specified in Part 3 of this Section.
- C. Strategies and Procedures Plan: Within 60 days from the Contractor's Notice to Proceed, submit 2 copies of the testing, adjusting, and balancing strategies and step-by-step procedures as specified in Part 3 "Preparation" Article below. Include a complete set of report forms intended for use on this Project.
- D. Certified Testing, Adjusting, and Balancing Reports: Submit 2 copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.
- E. Sample Report Forms: Submit 2 sets of sample testing, adjusting, and balancing report forms.
- F. Warranty: Submit 2 copies of special warranty specified in the "Warranty" Article below.

1.5 QUALITY ASSURANCE

- A. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by either AABC or NEBB. Agent shall function as a subcontractor responsible to the Plumbing Contractor.
- B. Testing, Adjusting, and Balancing Conference: Meet with the Department's and the Professional's representatives on approval of the testing, adjusting, and balancing strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of testing, adjusting, and balancing team members, equipment manufacturers' authorized service representatives, and other support personnel. Provide 7 days' advance notice of scheduled meeting time and location.
 - 1. Agenda Items: Include at least the following:
 - a. Submittal distribution requirements.
 - b. Contract Documents examination report.
 - c. Testing, adjusting, and balancing plan.
 - d. Work schedule and Project site access requirements.
 - e. Coordination and cooperation of trades and subcontractors.

- f. Coordination of documentation and communication flow.
- C. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
 - 2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.
- D. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC's "National Standards for Testing, Adjusting, and Balancing" or from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."
- E. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards or in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."
- F. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.6 PROJECT CONDITIONS

- A. Full Institution Occupancy: The Institution may occupy the site and building during the entire testing, adjusting, and balancing period. Cooperate with the Institution during testing, adjusting, and balancing operations to minimize conflicts with the Institution's operations.

1.7 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, and other mechanics to operate plumbing systems and equipment to support and assist testing, adjusting, and balancing activities.
- B. Notice: Provide 7 days' advance notice for each test. Include scheduled test dates and times.
- C. Perform testing, adjusting, and balancing after leakage and pressure tests on water distribution systems have been satisfactorily completed.

1.8 WARRANTY

- A. General Warranty: The national project performance guarantee specified in this Article shall not deprive the Department of other rights the Department may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

- B. Project Performance Guarantee: Provide a guarantee on AABC'S "National Standards" forms or on NEBB forms stating that AABC or NEBB will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing Agent fails to comply with the Contract Documents. Guarantee includes the following provisions:
 - 1. The certified Agent has tested and balanced systems according to the Contract Documents.
 - 2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.
 - 1. Verify that balancing devices, such as flow-control valves, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- B. Examine approved submittal data of plumbing systems and equipment.
- C. Examine equipment performance data. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of plumbing equipment when installed under conditions different from those presented when the equipment was performance tested at the factory.
- D. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.
- E. Examine system and equipment test reports.
- F. Examine plumbing system and equipment installations to verify that indicated balancing devices, such as flow-control valves, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- G. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- H. Examine strainers for clean screens and proper perforations.
- I. Examine equipment for installation and for properly operating safety interlocks and controls.

- J. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

3.2 PREPARATION

- A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.
- B. Complete system readiness checks and prepare system readiness reports. Verify the following:
 - 1. Water distribution piping systems are filled, clean, and free of air.
 - 2. Isolating and balancing valves are open and control valves are operational.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC national standards or in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
- B. Cut insulation for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.
- C. Mark equipment settings with paint or other suitable, permanent identification material, including valve indicators, and similar controls and devices, to show final settings.

3.4 GENERAL PROCEDURES FOR DOMESTIC WATER SYSTEMS

- A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare domestic water systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 - 1. Open all manual valves for maximum flow.
 - 2. Check that flow-control valves are set at indicated flow.
 - 3. Set system controls so automatic valves are wide open to coils.
 - 4. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 - 5. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.5 PROCEDURES FOR DOMESTIC WATER SYSTEMS

- A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:
 - 1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - 2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
 - 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
 - 4. Report flow rates that are not within plus or minus 5 percent of design.
- B. Set flow control valves at calculated settings.
- C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
 - 1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
 - 1. Determine the balancing station with the highest percentage over indicated flow.
 - 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
 - 3. Record settings and mark balancing devices.
- F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures.
- G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.6 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer, model, and serial numbers.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.

5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

3.7 TOLERANCES

- A. Set plumbing system water flow rates within the following tolerances:
 1. Water Flow Rate: 0 to minus 10 percent.

3.8 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to plumbing systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.9 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 1. Include a list of instruments used for procedures, along with proof of calibration.
- C. Final Report Contents: In addition to certified field report data, include the following:
 1. Pump curves.
 2. Manufacturers' test data.
 3. Field test reports prepared by system and equipment installers.
 4. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.
- D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
 1. Title page.
 2. Name and address of TAB firm.
 3. Project name.
 4. Project location.

5. Professional's name and address.
 6. Contractor's name and address.
 7. Report date.
 8. Signature of TAB firm who certifies the report.
 9. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 10. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 11. Nomenclature sheets for each item of equipment.
 12. Notes to explain why certain final data in the body of reports varies from indicated values.
- E. System Diagrams: Include schematic layouts of water distribution systems. Present each system with single-line diagram and include the following:
1. Water flow rates.
 2. Pipe and valve sizes and locations.
 3. Balancing stations.
 4. Position of balancing devices.

3.10 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
2. Randomly check the following for each system:
 - a. Verify that balancing devices are marked with final balance position.
 - b. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Professional.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Professional.
3. Professional shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.

4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
7. Request a second final inspection. If the second final inspection also fails, the Department shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.11 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions

END OF SECTION

SECTION 220719

PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes preformed, rigid and flexible pipe insulation; insulating cements; field applied jackets; accessories and attachments; and sealing components.
- B. Related Sections include the following:
 - 1. Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe insulation shields and protective saddles.

1.3 DEFINITIONS

- A. ASJ: All-service jacket.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated, identify thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Shop Drawings: Show details for the following:
 - 1. Application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Attachment and covering of heat tracing inside insulation.
 - 3. Insulation application at pipe expansion joints for each type of insulation.
 - 4. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Removable insulation at piping specialties, equipment connections, and access panels.
 - 6. Application of field-applied jackets.
- C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
 - 1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.

2. Sheet Form Insulation Materials: 12 inches square.
 3. Jacket Materials for Pipe: 12 inches long by NPS 2.
 4. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.
- D. Installer Certificates: Signed by Contractor certifying that installers comply with requirements.
- E. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- F. Field quality-control inspection reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Verify surface-burning characteristics of insulation materials by an independent testing agency. Require test report submittals where fire-performance characteristics are important requirements. Include test date and test methods.
- C. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- D. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Professional. Use materials indicated for the completed Work.
1. Piping Mockups:
 - a. One 10-foot section of NPS 2 straight pipe.
 - b. One 90-degree elbow.
 - c. One tee fitting.
 - d. One NPS 2 valve.
 - e. Four support hangers including hanger shield and insert.
 - f. One strainer with removable portion of insulation.
 - g. One reducer.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Professional seven days in advance of dates and times when mockups will be constructed.
4. Obtain Professional's approval of mockups before starting insulation application.
5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
6. Demolish and remove mockups when directed.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 1. Mineral-Fiber Insulation:
 - a. CertainTeed Manson.
 - b. Johns Manville Corp.
 - c. Knauf FiberGlass GmbH.
 - d. Owens-Corning Fiberglas Corp.

2. Flexible Elastomeric Thermal Insulation:

- a. Armstrong World Industries, Inc.
- b. Rubatex Corp.

2.2 INSULATION MATERIALS

- A. Mineral-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:
 1. Preformed Pipe Insulation: Comply with ASTM C 547, Type 1, with factory-applied, all-purpose, vapor-retarder jacket.
 2. Blanket Insulation: Comply with ASTM C 553, Type II, without facing.
 3. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:
 - a. Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
 - b. Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.
 4. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
 5. Mineral-Fiber Insulating Cements: Comply with ASTM C 195.
 6. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
- B. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 1. Adhesive: As recommended by insulation material manufacturer.
 2. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.
- C. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.3 FIELD-APPLIED JACKETS

- A. Insulation jackets in this Article are for field applications. ASTM C 921, Type I, is for use over insulation on ducts, equipment, and pipes operating at below ambient temperatures at least part of the time or where a vapor barrier is required. ASTM C 921, Type II, is for use over insulation on ducts and pipes operating above ambient temperatures or where a vapor retarder is not required.
- B. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- C. A properly sealed FSK jacket, common with most forms of factory-applied jackets for mineral-fiber insulation, meets vapor-retarder requirements of ASTM C 921, Type I.

- D. A properly sealed foil, scrim, kraft-paper (FSK) jacket, common with most forms of factory-applied jackets for mineral-fiber insulation, meets vapor-retarder requirements of ASTM C 921, Type I.
- E. Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.
- F. Although other thicknesses for PVC jackets are available, 25/50 flame-spread/smoke-developed ratings apply only to thicknesses of 20 mils (0.5 mm) and less.
- G. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.
 - 1. Adhesive: As recommended by insulation material manufacturer.
 - 2. PVC jackets are available in several colors. Colored jackets may be used to replace field painting. Ultraviolet rays fade colors in exterior applications. Some colors (black, gray, and white) do not fade as quickly as other colors (red, orange, and green).
 - 3. PVC Jacket Color: White or gray.
- H. Heavy PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 30-mil- thick, high-impact, ultraviolet-resistant PVC.
 - 1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
 - 2. Adhesive: As recommended by insulation material manufacturer.

2.4 ACCESSORIES AND ATTACHMENTS

- A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd.
 - 1. Tape Width: 4 inches.

2.5 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 COMMON INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 1. Install insulation continuously through hangers and around anchor attachments.
 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.

- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Firestopping and fire-resistive joint sealers are specified in Division 7 Section "Through-Penetration Firestop Systems."
- D. Insulation Installation at Floor Penetrations:
 - 1. Pipe: Install insulation continuously through floor penetrations.
 - 2. Seal penetrations through fire-rated assemblies according to Division 7 Section "Through-Penetration Firestop Systems."

3.5 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 - 4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install mitered sections of pipe insulation.
 - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 - 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 3. Install insulation to flanges as specified for flange insulation application.
 - 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.6 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

- B. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturers recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.8 FINISHES

- A. Coordinate first paragraph below with Division 9 painting Sections. If PVC jackets are specified, consult jacket manufacturers to determine suitable paint products and edit painting Sections to suit Project.
- B. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 9 painting Sections.
- C. Retain paint system in subparagraph and associated subparagraph below for a flat, latex-emulsion size over insulation covering an exterior that is subject to normal use and moderate environments.
- D. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- E. Color: Final color as selected by Professional. Vary first and second coats to allow visual inspection of the completed Work.

3.9 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
1. Inspect pipe, fittings, strainers, and valves, randomly selected by Professional, by removing field-applied jacket and insulation in layers in reverse order of their installation.
- B. All insulation applications will be considered defective Work if sample inspection reveals non-compliance with requirements. Remove defective Work.
- C. Install new insulation and jackets to replace insulation and jackets removed for inspection. Repeat inspection procedures after new materials are installed.

3.10 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Below-grade piping.
 - 2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
- C. All aboveground PVC drainage (Sanitary, Waste, Storm and Condensate drainage) system piping located near or adjacent to any guest rooms, hospitality or public spaces shall be fully covered with piping insulation as specified to eliminate and attenuate any noise related to flow in drainage piping system. This shall include vertical stacks or horizontal drainage piping concealed above ceilings, below floors, in walls or in pipe chases near or adjacent to designated guest rooms or hospitality areas.

3.11 INTERIOR INSULATION APPLICATION SCHEDULE

- A. Service: Domestic hot and recirculated hot water. (All Metallic and Plastic / PEX piping systems)
 - 1. Operating Temperature: 60 to 120 deg F.
 - 2. Insulation Material: Mineral fiber.
 - 3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Pipe, 1-1/4 inches diameter and smaller: 1 inch.
 - b. Pipe, 1-1/2 inches diameter and larger: 1-1/2 inch.
 - 4. Field-Applied Jacket: PVC, at all exposed locations, excluding Boiler Rooms.
 - 5. Vapor Retarder Required: No.
 - 6. Finish: None.
- B. Service: Domestic cold water. (Metallic piping systems only – not required for PEX piping system.)
 - 1. Operating Temperature: 35 to 75 deg F.
 - 2. Insulation Material: Mineral fiber or flexible elastomeric, as herein specified.
 - 3. Insulation Thickness: 1/2 inch.
 - 4. Field-Applied Jacket: PVC, at all exposed locations, excluding Boiler Rooms.
 - 5. Vapor Retarder Required: Yes.
 - 6. Finish: None.
- C. Service: Sanitary, Waste and Vent systems. (Elimination of potential condensation and noise attenuation.)
 - 1. Operating Temperature: 32 to 100 deg F.
 - 2. Insulation Material: Mineral fiber or flexible elastomeric.
 - 3. Insulation Thickness: 1-inch.

4. Field-Applied Jacket: None.
5. Vapor Retarder Required: Yes.
6. Finish: None.

D. Service: Rainwater conductors. (Elimination of potential condensation and noise attenuation.)

1. Operating Temperature: 32 to 100 deg F.
2. Insulation Material: Mineral fiber or flexible elastomeric.
3. Insulation Thickness: 1-inch.
4. Field-Applied Jacket: None.
5. Vapor Retarder Required: Yes.
6. Finish: None.

E. Service: Roof drain bodies. (Elimination of condensation and noise attenuation.)

1. Operating Temperature: 32 to 100 deg F.
2. Insulation Material: Mineral fiber or flexible elastomeric.
3. Insulation Thickness: 1 inch.
4. Field-Applied Jacket: None.
5. Vapor Retarder Required: Yes.
6. Finish: None.

F. Service: Condensate drainage piping. (Elimination of condensation and noise attenuation.)

1. Operating Temperature: 35 to 75 deg F.
2. Insulation Material: Flexible elastomeric.
3. Insulation Thickness: 1/2 inch.
4. Field-Applied Jacket: None.
5. Vapor Retarder Required: Yes.
6. Finish: None.

G. Service: Exposed sanitary drains and domestic water supplies and stops for fixtures for the disabled.

1. Operating Temperature: 35 to 120 deg F.
2. Insulation Material: Mineral fiber or flexible elastomeric.
3. Insulation Thickness: 1 inch.
4. Field-Applied Jacket: PVC P-trap and supply covers.
5. Vapor Retarder Required: No.
6. Finish: None

3.12 OUTDOOR, EXPOSED - ABOVEGROUND PIPING INSULATION SCHEDULE

A. Service: Domestic hot and recirculated hot water. Where heat tracing is installed:

1. Operating Temperature: 60 to 120 deg F.
2. Insulation Material: Mineral fiber.
3. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Pipe, 1-1/4 inches diameter and smaller: 1 inch.

- b. Pipe, 1-1/2 inches diameter and larger: 2 inch.
- 4. Field-Applied Jacket: PVC, at all exposed locations, excluding Boiler Rooms.
- 5. Vapor Retarder Required: No.
- 6. Finish: None.

- B. Service: Domestic cold water. Where heat tracing is installed:
 - 1. Operating Temperature: 35 to 75 deg F.
 - 2. Insulation Material: Mineral fiber or flexible elastomeric, as herein specified.
 - 3. Insulation Thickness:
 - a. Pipe, 1-1/4 inches diameter and smaller: 1 inch.
 - b. Pipe, 1-1/2 inches diameter and larger: 2 inch.
 - 4. Field-Applied Jacket: PVC, at all exposed locations, excluding Boiler Rooms.
 - 5. Vapor Retarder Required: Yes.
 - 6. Finish: None.

- C. Service: Rainwater conductors.
 - 1. Operating Temperature: 32 to 100 deg F.
 - 2. Insulation Material: Mineral fiber.
 - 3. Insulation Thickness: 2-inch.
 - 4. Field-Applied Jacket: None.
 - 5. Vapor Retarder Required: Yes.
 - 6. Finish: None.

- D. Service: Roof drain bodies. Where heat tracing is installed:
 - 1. Operating Temperature: 32 to 100 deg F.
 - 2. Insulation Material: Mineral fiber or flexible elastomeric.
 - 3. Insulation Thickness: 1 inch.
 - 4. Field-Applied Jacket: None.
 - 5. Vapor Retarder Required: Yes.
 - 6. Finish: None.

- E. Service: Condensate drain piping.
 - 1. Operating Temperature: 35 to 75 deg F.
 - 2. Insulation Material: Flexible elastomeric.
 - 3. Insulation Thickness: 1/2 inch.
 - a. Pipe, 2 inches diameter and smaller: 1 inch.
 - b. Pipe, 2-1/2 inches diameter and larger: 2 inch.
 - 4. Field-Applied Jacket: None.
 - 5. Vapor Retarder Required: Yes.
 - 6. Finish: None.

F. Service: Exposed sanitary piping where heat tracing is installed:

1. Operating Temperature: 35 to 120 deg F.
2. Insulation Material: Mineral fiber or flexible elastomeric.
3. Insulation Thickness: 1 inch.
 - a. Pipe, 2 inches diameter and smaller: 1 inch.
 - b. Pipe, 2-1/2 inches diameter and larger: 2 inch.
4. Field-Applied Jacket: PVC P-trap and supply covers.
5. Vapor Retarder Required: No.
6. Finish: None

END OF SECTION

SECTION 221116

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:

- 1. Water Distribution Piping From Locations Indicated To Fixtures And Equipment Inside Building.

B. Related Sections:

- 1. Section 220500 - Common Work Results for Plumbing.
- 2. Section 220523 - Plumbing Valves.
- 3. Section 221119 - Domestic Water Piping Specialties.

1.3 DEFINITIONS

- A. Service Entrance Piping: Water piping at entry into building between water service piping and water distribution piping (by Plumbing Subcontractor, beginning at 5'-0" outside of building).

1.4 SYSTEM PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with the following minimum working-pressure ratings, unless otherwise indicated:
 - 1. Service Entrance Piping: 160 psig.

1.5 SUBMITTALS

- A. Submit "Letter of Conformance" in accordance with Section 103300 indicating specified items selected for use in project.

- B. Product Data:
 - 1. Water Samples, Test Results, and Reports: Specified in "Field Quality Control" and "Cleaning" articles.

1.6 QUALITY ASSURANCE

- A. All piping materials and installation shall comply with the State of Wisconsin plumbing code and city of Milwaukee ordinances.
- B. Provide listing/approval stamp, label, or other marking on piping made to specified standards.
- C. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
- D. Potable-water piping and components shall comply with NSF 14 and NSF/ANSI 61 Annex G and NSF/ANSI/372 for 0.25% maximum lead content requirement. Plastic piping components shall be marked with "NSF-pw".

PART 2 - PRODUCTS

2.1 PIPES AND TUBES

- A. General: Applications of the following pipe and tube materials shall comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."
- C. Soft Copper Tube: ASTM B 88, Types K and L, water tube, annealed temper.
- D. Hard Copper Tube: ASTM B 88, Types L, water tube, drawn temper.

2.2 PIPE AND TUBE FITTINGS

- A. Copper, Solder-Joint Pressure Fittings: ASME B16.18 cast-copper alloy or ASME B16.22 wrought copper.
- B. Copper Pressure-Seal-Joint Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. NIBCO INC.
 - c. Viega LLC.

2. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
3. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

2.3 JOINING MATERIALS

- A. Refer to Section 220500 "Common Work Results for Plumbing" for commonly used joining materials.
- B. Solder: ASTM B 32, Alloy Sn95, Sn94, or E; lead free.
- C. Brazing Filler Metal: AWS A5.8, BCuP, copper phosphorus or BA_g, silver classification.
- D. Copper Pressure-Seal-Joint Fittings: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
- E. Transition Couplings: Coupling or other manufactured fitting same size as, with pressure rating at least equal to, and with ends compatible with piping to be joined.
- F. Flux: ASTM B 813, water flushable.

2.4 VALVES

- A. Refer to Section 220523 "Plumbing Valves" for general-duty valves.
- B. Refer to Section 221119 "Domestic Water Piping Specialties" for special-duty valves.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 2 for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. General installation applications.
 1. Install only the specified metallic copper water piping systems with applicable insulation in designated "return air plenum" areas or spaces. No PVC, CPVC, PEX piping or associated plastic piping will be accepted or approved for designated plenum areas. Plenum wrap insulation will not accepted as an alternative for metallic piping in plenum area installations.
 2. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below, unless otherwise indicated.
 3. Install only the specified metallic copper supply piping with insulation in mechanical equipment area or other spaces where the temperature can exceed ambient temperatures.

4. Install only the specified metallic copper piping with insulation at the domestic water heater assembly and the associated component piping.
- B. Underground, Water Service Piping: Use the following:
1. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper
- C. Aboveground, Water Distribution Piping: Use the following:
1. All Water Service and Distribution supply mains: Hard copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings.
 2. All Water Service and Distribution supply mains: Hard copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings.

3.3 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply (Refer to Section 220523 "Plumbing Valves"):
1. Shutoff Duty: Use ball valves.
 2. Throttling Duty: Use ball valves.
 3. Balancing Duty: Use Tour and Anderson valve with metering port.

3.4 PIPING INSTALLATION, GENERAL

- A. Refer to Section 220500 "Common Work Results for Plumbing" for basic piping installation.

3.5 SERVICE ENTRANCE PIPING INSTALLATION

- A. Extend service entrance piping to exterior water service piping in sizes and locations indicated for service entrances into building. Refer to Section 02500 "Utility Services" for water service piping.
- B. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside building at each service entrance pipe per local Utility Code requirements.
- C. Ductile-Iron, Service Entrance Piping: Comply with AWWA C600. Install buried piping between shutoff valve and connection to water service piping with restrained joints. Anchor pipe to wall or floor at entrance. Include thrust-block supports at vertical and horizontal offsets.
1. Encase piping with polyethylene film according to ASTM A 674 or AWWA C105 if required by the local authority having jurisdiction.
- D. Install wall penetration system at each service entrance pipe penetration through foundation wall. Make installation watertight. Refer to Section 220500 "Common Work Results for Plumbing" for wall penetration systems.

3.6 WATER DISTRIBUTION PIPING INSTALLATION

- A. Install piping with 0.25 percent slope downward toward drain.

3.7 JOINT CONSTRUCTION

- A. Refer to Section 220500 "Common Work Results for Plumbing" for basic piping joint construction.

3.8 VALVE INSTALLATION

- A. Sectional Valves: Install ball valves close to main on each branch and riser serving plumbing fixtures or equipment, and where indicated.
- B. Shutoff Valves: Install ball shutoff valve on each water supply to equipment, on each supply to plumbing fixtures without supply stops, and where indicated.
- C. Drain Valves: Install drain valves for equipment, at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
 - 1. Install hose-end drain valves with cap and chain at low points in water mains, risers, and branches.
 - 2. Install stop-and-waste drain valves where indicated.
- D. Balancing Valves: Install in each hot-water circulation return branch, discharge side of each pump and circulator, and where indicated. Refer to Section 221119 "Plumbing Specialties" for balancing valves.

3.9 HANGER AND SUPPORT INSTALLATION

- A. Refer to Section 220529 "Hangers and Supports" for pipe hanger and support devices. Install the following:
 - 1. Riser clamps, MSS Type 8 or Type 42, for vertical runs.
 - 2. Adjustable steel clevis hangers, MSS Type 1, for individual, straight, horizontal runs 100 feet and less.
 - 3. Adjustable roller hangers, MSS Type 43, for individual, straight, horizontal runs longer than 100 feet.
 - 4. Spring cushion rolls, MSS Type 49, if indicated, for individual, straight, horizontal runs longer than 100 feet.
 - 5. Pipe rolls, MSS Type 44, for multiple, straight, horizontal runs 100 feet or longer. Support pipe rolls on trapeze.
 - 6. Spring hangers, MSS Type 52, for supporting base of vertical runs.
- B. Install supports according to Section 220529 "Hangers and Supports."
- C. Support vertical piping and tubing at base and at each floor.

- D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for copper tubing with the following maximum spacing and minimum rod diameters:
 - 1. 3/4-Inch NPS and Smaller: Maximum horizontal spacing, 60 inches with 3/8-inch minimum rod diameter; maximum vertical spacing, 10 feet.
 - 2. 1-Inch NPS: Maximum horizontal spacing, 72 inches with 3/8-inch minimum rod diameter; maximum vertical spacing, 10 feet.
 - 3. 1-1/4-Inch NPS: Maximum horizontal spacing, 72 inches with 3/8-inch minimum rod diameter; maximum vertical spacing, 10 feet.
 - 4. 1-1/2 and 2-Inch NPS: Maximum horizontal spacing, 96 inches with 3/8-inch minimum rod diameter; maximum vertical spacing, 10 feet.
 - 5. 2-1/2-Inch NPS: Maximum horizontal spacing, 108 inches with 1/2-inch minimum rod diameter; maximum vertical spacing, 10 feet.
 - 6. 3-Inch NPS: Maximum horizontal spacing, 10 feet with 1/2-inch minimum rod diameter; maximum vertical spacing, 10 feet.
 - 7. 3-1/2-Inch NPS: Maximum horizontal spacing, 10 feet with 1/2-inch minimum rod diameter; maximum vertical spacing, 10 feet.
 - 8. 4- and 6-Inch NPS: Maximum horizontal spacing, 10 feet with 1/2-inch minimum rod diameter; maximum vertical spacing, 10 feet.
- F. Support horizontal and vertical runs of PEX tubing to comply with manufacturer's written instructions, recommendations, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent

3.10 CONNECTIONS

- A. Connect service entrance piping to exterior water service piping. Use transition fitting to join dissimilar piping materials.

3.11 FIELD QUALITY CONTROL

- A. Inspect service entrance piping and water distribution piping as follows:
 - 1. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
 - 2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - a. Roughing-In Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test service entrance piping and water distribution piping as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
3. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for 4 hours. Leaks and loss in test pressure constitute defects that must be repaired.
4. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.12 CLEANING

A. Clean and disinfect service entrance piping and water distribution piping as follows:

1. Purge new piping and parts of existing water piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed, procedure described in either AWWA C651 or AWWA C652 or as described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for 3 hours.
 - c. Flush system with clean, potable water until chlorine is no longer in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows contamination.

B. Prepare and submit reports for purging and disinfecting activities.

C. Clean interior of piping system. Remove dirt and debris as work progresses.

3.13 COMMISSIONING

- A. Fill water piping. Check components to determine that they are not air bound and that piping is full of water.
- B. Perform the following steps before putting into operation:
 - 1. Close drain valves, hydrants, and hose bibbs.
 - 2. Open shutoff valves to fully open position.
 - 3. Open throttling valves to proper setting.
 - 4. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
 - 5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 - 6. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and that cartridges are clean and ready for use.
- C. Check plumbing equipment and verify proper settings, adjustments, and operation in compliance with manufacturer's operating instructions. Do not operate water heaters before filling with water.
- D. Energize pumps and verify proper operation in compliance with manufacturer's operating instructions.

END OF SECTION

SECTION 221119

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes the following domestic water piping specialties:
 - 1. Vacuum breakers.
 - 2. Backflow preventers.
 - 3. Balancing valves.
 - 4. Temperature water mixing valves.
 - 5. Strainers.
 - 6. Hose bibbs.
 - 7. Wall hydrants.
 - 8. Drain valves.
 - 9. Water hammer arresters.
 - 10. Water filters.
- B. Related Sections include the following:
 - 1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.

1.3 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.

- D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. NSF Compliance:
 - 1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
- C. Potable-water piping and components shall comply with NSF 14 and NSF/ANSI 61 Annex G and NSF/ANSI/372 for 0.25% maximum lead content requirement. Plastic piping components shall be marked with "NSF-pw".

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Conbraco Industries, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
 - c. Zurn Plumbing Products Group; Wilkins Div.
 - 2. Standard: ASSE 1001.
 - 3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
 - 4. Body: Bronze.
 - 5. Inlet and Outlet Connections: Threaded.
 - 6. Finish: Rough bronze or Chrome plated.
- B. Hose-connection vacuum breakers in paragraph below are for low hazard and are not suitable for continuous pressure. Outlet size is garden-hose thread.
- C. Hose-Connection Vacuum Breakers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Conbraco Industries, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
 - c. Woodford Manufacturing Company.
 - d. Zurn Plumbing Products Group; Light Commercial Operation.

2. Standard: ASSE 1011.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

D. Pressure Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Conbraco Industries, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
 - c. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
5. Accessories:
 - a. Valves: Ball type, on inlet and outlet.

2.2 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Ames Co.
 - b. Watts Industries, Inc.; Water Products Div.
2. Standard: ASSE 1012.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/2 NPS 3/4.
5. Body: Bronze.
6. End Connections: Union, solder joint.
7. Finish: Chrome plated.

B. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Ames Co.
 - b. Watts Industries, Inc.; Water Products Div.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.

5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Configuration: Designed for horizontal, straight through flow.
8. Basis of Design: Series 909 reduced pressure zone assemblies.
9. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

C. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Ames Co.
 - b. Watts Industries, Inc.; Water Products Div.
2. Standard: ASSE 1047.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C511 or that is FDA approved or stainless steel for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Configuration: Designed for horizontal, straight through flow.
8. Basis of Design: Series 909RPDA reduced pressure detector assemblies.
9. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

D. Dual-Check-Valve Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Watts Industries, Inc.; Water Products Div.
2. Standard: ASSE 1024.
3. Operation: Continuous-pressure applications.
4. Body: Bronze with union inlet.

E. Hose-Connection Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:

- a. Watts Industries, Inc.; Water Products Div.
 - b. Woodford Manufacturing Company.
2. Standard: ASSE 1052.
 3. Operation: Up to 10-foot head of water back pressure.
 4. Inlet Size: NPS 3/4.
 5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
 6. Capacity: At least 3-gpm flow.

2.3 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Armstrong International, Inc.
 - b. ITT Industries; Bell & Gossett Div.
 - c. NIBCO INC.
2. Type: Ball valve with two readout ports and memory setting indicator.
3. Body: Brass or bronze,
4. Size: Same as connected piping, but not larger than NPS 2.
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.
6. Basis of Design: Bell & Gossett Circuit Setter Plus - Lead Free - Calibrated Balancing Valves of Series Model "CB".

B. Thermostatic Zone Balancing Valve Assembly:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Acorn Controls – Thermo Flow – Thermostatic Zone Valve -Model "TZV-2".
 - b. ThermOmegaTech – Circuit Solver- Model – CSUA- 120- CV1
2. Valve assembly shall be self-contained, self-adjusting, and automatically maintains circulated hot water temperature in the domestic hot water system loops without balancing or control mechanisms. Valve shall regulate the flow of recirculated domestic hot water based on water temperature entering the valve regardless of system operating pressure. When fully closed the valve shall bypass a minimum flow to maintain dynamic control of the recirculating loop. Valve shall be adjusted on site to 120 degrees F. Valve shall modulate open and closed within a 10 degree F. range.
3. Valve body and all internal components shall be constructed of solid brass, and shall include female NPT connections. Valve shall also include an integral temperature gauge, check valve and strainer. Units shall be NSF 61 compliant with zero lead content for use in domestic water systems.
4. Unit shall be provided as an assembly with balancing valve and inlet and outlet ball valves. Provide necessary adapters for transition to copper piping systems.

2.4 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Individual-Fixture, Thermostatic, Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Lawler Manufacturing Company, Inc.
 - b. Leonard Valve Company.
 - c. Powers; a Watts Industries Co.
2. Standard: ANSI/ ASSE 1016. Thermostatically controlled water tempering valve.
3. Pressure and Flow Rating: 150 psig – Maximum 8 gpm..
4. Type: Exposed-mounting or Cabinet-type, thermostatically controlled water mixing valve.
5. Material: Brass or Bronze body with corrosion-resistant interior components.
6. Connections: Threaded or union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.

2.5 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
2. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
3. Screen: Stainless steel with round perforations, unless otherwise indicated.
4. If retaining more than one screen size, indicate screen size on Drawings.
5. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.020 inch.
 - b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
 - c. Strainers NPS 5 and Larger: 0.10 inch.
6. Drain: Pipe plug or Factory-installed, hose-end drain valve.

B. Basis-of-Design Product: Zurn Model No. Z-81507.Hose Bibbs (HB-2):

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.

9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Wheel handle.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.6 HOSE BIBBS

A. Hose Bibbs (HB-1):

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Wheel handle.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.
16. Basis-of-Design Product: Zurn Model No. Z-80701.

2.7 WALL HYDRANTS

A. Non-freeze Wall Hydrants (WH-1):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - b. Woodford Manufacturing Company.
 - c. Zurn Plumbing Products Group; Light Commercial Operation.
2. Standard: ASME A112.21.3M for concealed outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig .
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.

8. Box: Deep, flush mounting with cover.
9. Box and Cover Finish: Polished nickel bronze.
10. Retain last three subparagraphs above for concealed-outlet-type wall hydrants or first two subparagraphs below for exposed-outlet-type wall hydrants.
11. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
12. Nozzle and Wall-Plate Finish: Polished nickel bronze.
13. Operating Keys(s): One with each wall hydrant.
14. Basis-of-Design Product: Zurn Model No. Z-1310-34FS or Z-1310-34UN.

2.8 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: NPS 3/4.
4. Body: ASTM B 62 bronze.
5. Inlet: NPS 3/4 threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves:

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig minimum CWP or Class 125.
3. Size: NPS 3/4.
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 side outlet with cap.

2.9 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:

- a. MIFAB, Inc.
 - b. PPP Inc.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Watts Drainage Products Inc.
2. Standard: ASSE 1010 or PDI-WH 201.
 3. Type: Copper tube with piston.
 4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.10 WATER FILTERS

- A. Filter shall have a nominal degree of filtration of 5 microns, with a flow rate of up to 2 GPM, and shall include a taste/odor removal cartridge. Unit shall be wall mountable with integral bracket. Filter shall be the Cuno Aqua-Pure Model AP200 with No. AP217 taste/odor cartridge, or equal to. Contractor shall furnish one (1) extra filter cartridge for spare.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- C. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.
- D. Install balancing valves in locations where they can easily be adjusted.
- E. Install thermostatic balancing valves on branch return circulation lines at the proper system temperature and size.
- F. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 1. Install thermometers and water regulators if specified.
 2. Install cabinet-type units recessed in or surface mounted on wall as specified.

- G. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.
- H. Water hammer arresters in first paragraph below are best shown on water risers and details. Specifying number, size, and location here is difficult.
- I. Install water hammer arresters in water piping according to PDI-WH 201.
- J. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.
- K. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Pressure vacuum breakers.
 - 2. Reduced-pressure-principle backflow preventers.
 - 3. Double-check backflow-prevention assemblies.
 - 4. Dual-check-valve backflow preventers.
 - 5. Reduced-pressure-detector, fire-protection backflow-preventer assemblies.
 - 6. Water pressure-reducing valves.
 - 7. Calibrated balancing valves.
 - 8. Primary, thermostatic, water mixing valves.
 - 9. Supply-type trap-seal primer valves.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
 - 1. Test each pressure vacuum breaker, reduced-pressure-principle backflow preventer, and double-check backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature mixing valves

END OF SECTION

SECTION 221123

DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Pumps For The Building Potable-Water Systems.

- B. Related Sections:

- 1. Section 220519 - Meters and Gages for Plumbing Systems.
 - 2. Section 220523 - Plumbing Valves.
 - 3. Section 220593 - Testing, Adjusting and Balancing of Plumbing Systems.
 - 4. Division 26 Sections for power-supply wiring, field-installed disconnects, electrical devices, and motor controllers.

1.3 SUBMITTALS

- A. Submit "Letter of Conformance" in accordance with Section 013300 indicating items selected for use in project.

- B. Product Data:

- 1. Include certified performance curves and rated capacities of selected models; shipping, installed, and operating weights; furnished specialties; and accessories for each type and size of pump specified. Indicate pumps' operating point on curves.

- C. Maintenance Data: For each pump specified to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain same type of pumps through one source from a single manufacturer.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Marketplace Preferred Program Manufacturers:
 - 1. None.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1. In-Line Circulators:
 - a. Armstrong Pumps, Inc. (800-FLOW-845)
 - b. ITT Fluid Technology Corp.; ITT Bell & Gossett Div. (800-908-8932)
 - c. Taco, Inc. (401-942-8000)

2.2 PUMPS, GENERAL

- A. Description: Factory-assembled and -tested, single-stage, centrifugal pump units; complying with UL 778; suitable for potable-water service; with all-bronze or stainless-steel construction and components in contact with water made of corrosion-resistant materials.
- B. Motors: Comply with requirements in Division 15 Section "Motors" with built-in thermal-overload protection appropriate for motor size and duty.
- C. End Connections for NPS 2 (DN50) and Smaller: Threaded. Pumps available only with flanged ends may be furnished with threaded companion flanges.
- D. End Connections for NPS 2-1/2 (DN65) and Larger: Flanged.
- E. Finish: Manufacturer's standard paint applied to factory-assembled and -tested units before shipping.
- F. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles.

2.3 IN-LINE CIRCULATORS

- A. Description: Horizontal in-line domestic hot water system return circulator, rated for 125-psig minimum working pressure and minimum continuous water temperature of 225 deg F.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Armstrong Pumps.
 - b. ITT Bell & Gossett.
 - c. Grunfos Pumps
 - d. Taco
 2. Basis of Design: Refer to the Plumbing Drawings for Schedules and Details to identify the characteristics and details of the designated circulating pumps.
 3. Construction: Radially split, all-bronze casing.
 4. Impeller: ASTM B 36/B 36M, rolled brass; or ASTM B 584, cast bronze; overhung, single suction, and keyed to shaft.
 5. Seal: Mechanical.
 6. Shaft and Sleeve: Steel shaft, with oil-lubricated copper sleeve.
 7. Pump Bearings: Oil-lubricated, bronze-journal or thrust type.
 8. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
 9. Motor: Single speed, with oil-lubricated bearings, unless otherwise indicated; and resiliently mounted to pump casing.
 - a. Motor Size: For motors larger than 1/2 hp, select motor size that will not overload through full range of pump performance curve.
 10. Circulating pumps will be controlled during off periods or non-occupancy of the building under the Automatic Temperature Control.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water distribution piping to verify actual locations of connections before pump installation.

3.2 INSTALLATION

- A. Install pumps according to manufacturer's written instructions and with access for periodic maintenance, including removing motors, impellers, couplings, and accessories.
- B. Support pumps and piping so weight of piping is not supported by pumps.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:
 - 1. Connect water distribution piping to pumps. Install suction and discharge pipe equal to or greater than size of pump nozzles. Refer to Section 22 11 16 "Domestic Water Piping."
 - 2. Install shutoff valve and strainer on suction side of pumps, and check valve and throttling valve on discharge side of pumps. Install valves same size as connected piping. Refer to Section 22 05 23 "Plumbing Valves" for general-duty valves.
 - 3. Install pressure gages at suction and discharge of pumps. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Refer to Section 22 05 19 "Meters and Gages for Plumbing Piping" for pressure gages and gage connectors.
- B. Electrical wiring and connections are specified in Division 26 Sections.
- C. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 COMMISSIONING

- A. Check suction piping connections for tightness.
- B. Final Checks before Starting: Perform the following preventive maintenance operations:
 - 1. Lubricate oil-lubricated-type bearings.
 - 2. Verify that pump is free to rotate by hand and that pump for handling hot liquids is free to rotate with pump hot and cold. Do not operate pump if it is bound or drags, until cause of trouble is determined and corrected.
 - 3. Verify that pump controls are correct for required application.
- C. Starting procedure for pumps is as follows:
 - 1. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
 - 2. Open circulating line valve if pump should not be operated against dead shutoff.
 - 3. Start motor.
 - 4. Open discharge valve slowly.
 - 5. Check general mechanical operation of pump and motor.
 - 6. Close circulating line valve once there is sufficient flow through pump to prevent overheating.

3.5 DEMONSTRATION

- A. Contractor shall train Client Agency's maintenance personnel to adjust, operate, and maintain pumps as specified below:
 - 1. Conduct training as specified.
 - 2. Train Client Agency's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining pumps.

END OF SECTION

SECTION 221124

DOMESTIC-WATER PACKAGED BOOSTER PUMPS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Simplex, constant-speed booster pumps.
- B. Related Requirements:
 - 1. Section 221123 "Domestic Water Pumps" for domestic-water circulation pumps.

1.3 DEFINITIONS

- A. VFC: Variable-frequency controller.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, and dimensions of individual components and profiles.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For booster pumps.
 - 1. Include plans, elevations, sections, and details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

- C. Delegated-Design Submittal: For domestic-water packaged booster pumps.
 - 1. Include design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

- A. Certificates: For booster pumps, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For booster pumps to include in emergency, operation, and maintenance manuals.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Retain protective coatings and flange's protective covers during storage.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.
- B. Seismic Performance: Booster pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the booster pump will remain in place without separation of any parts from the booster pump when subjected to the seismic forces specified."

2.2 SIMPLEX BOOSTER PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
1. Duramac.
 2. Grundfos.
 3. Goulds.
- B. Description: Factory-assembled and -tested, fluid-handling system for domestic water, with pump, piping, valves, specialties, and controls, and mounted on base.
- C. Basis of Design: Duramac - Dual Mode Simplex Model #17044C070PCZ-S, or approved equal.
- D. Pump:
1. Type: End suction as defined in HI 1.1-1.2 and HI 1.3 for end-suction, close-coupled, single-stage, overhung-impeller, centrifugal pump.
 2. Casing: Radially split; stainless steel.
 3. Impeller: Closed, stainless steel; statically and dynamically balanced and keyed to shaft.
 4. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve and deflector.
 5. Seal: Mechanical.
 6. Orientation: Mounted horizontally.
- E. Motor: Single speed, with grease-lubricated, ball-bearings, and directly mounted to pump casing. Select motor that will not overload through full range of pump performance curve.
- F. Piping: Copper tube and copper fittings.
- G. Valves:
1. Shutoff Valves NPS 2 and Smaller: Two-piece, full-port ball valve, in pump suction and discharge piping.
 2. Shutoff Valves NPS 2-1/2 and Larger: Gate valve, in pump suction and discharge piping.
 3. Check Valve NPS 2 and Smaller: Swing type in pump discharge piping.
 4. Check Valve NPS 2-1/2 and Larger: Silent type in pump discharge piping.
 5. Control Valve: Adjustable, automatic, pilot-operated, pressure-reducing type in pump discharge piping.
 6. Control Valve: Combination adjustable, automatic, pilot-operated pressure-reducing-and-check type in pump discharge piping.
 7. Thermal-Relief Valve: Temperature-and-pressure relief type in pump discharge piping.
- H. Dielectric Fittings: With insulating material to isolate joined dissimilar metals.
- I. Hydropneumatic Tank: Precharged diaphragm or bladder tank made of materials complying with NSF 61 and NSF 372.

- J. Control Panel: Factory installed and connected as an integral part of booster pump; automatic for single-pump, with load control and protection functions. Digital control with dual modes of operation dry run protection and pressure gauge.
- K. Base: Stainless steel.
- L. Capacities and Characteristics:
 - 1. Minimum Pressure Rating: 125 psig.
 - 2. Booster-Pump Capacity: 70 gpm.
 - 3. Total Dynamic Head: 46 feet.
 - 4. Speed: 3500 rpm.
 - 5. Inlet Size: 1-1/2" NPS.
 - 6. Outlet Size: 1-1/2" NPS.
 - 7. Electrical Characteristics:
 - a. Motor Horsepower: 2 hp
 - b. Volts: 240 V.
 - c. Phases: Single.
 - d. Hertz: 60 Hz.
 - 8. Hydropneumatic Tank:
 - a. Minimum Water Volume Capacity: 20 gal..
 - b. Pressure Rating: 125, 150 psig.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for booster pumps to verify actual locations of piping connections before booster-pump installation.

3.2 INSTALLATION

- A. Equipment Mounting:
 - 1. Install booster pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Comply with requirements for vibration isolation and seismic control device required.
- B. Support connected domestic-water piping so weight of piping is not supported by booster pumps.

3.3 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect domestic-water piping to booster pumps. Install suction and discharge pipe equal to or greater than size of system suction and discharge headers.
 - 1. Install shutoff valves on piping connections to booster-pump suction and discharge headers. Install ball or butterfly same size as suction and discharge headers. Comply with requirements for general-duty valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."
 - 2. Install union or flanged connections on suction and discharge headers at connection to domestic-water piping. Comply with requirements for unions and flanges specified in Section 221116 "Domestic Water Piping."
 - 3. Install valved bypass, same size as and between piping, at connections to booster-pump suction and discharge piping. Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."
 - 4. Install flexible connectors, same size as piping, on piping connections to booster-pump suction and discharge headers. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."
 - 5. Install piping adjacent to booster pumps to allow service and maintenance.

3.4 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Perform visual and mechanical inspection.
 - 2. Leak Test: After installation, charge booster pump and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start booster pumps to confirm proper motor rotation and booster-pump operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Pumps and controls will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Adjust booster pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust pressure set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting booster pump to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.8 DEMONSTRATION

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

END OF SECTION

SECTION 221126

FACILITY LIQUEFIED-PETROLEUM GAS PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping specialties.
 - 3. Piping and tubing joining materials.
 - 4. Valves.
 - 5. Pressure regulators.
 - 6. Concrete bases.

1.3 DEFINITIONS

- A. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- D. LPG: Liquefied-petroleum gas.

1.4 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. For Piping Containing Only Vapor:
 - a. Piping and Valves: 125 psig unless otherwise indicated.

2. For Piping Containing Liquid:

- a. Piping between Shutoff Valves: 350 psig unless otherwise indicated.
- b. Piping Other Than Above: 250 psig unless otherwise indicated.
- c. Valves and Fittings: 250 psig unless otherwise indicated.

- B. LPG System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig and is reduced to secondary pressure of 0.5 psig or less.

1.5 ACTION SUBMITTALS

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

1. Piping specialties.
2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
3. Pressure regulators. Indicate pressure ratings and capacities.
4. Dielectric fittings.

- B. Shop Drawings: For facility LPG piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: 1/4 inch per foot.
2. Detail mounting, supports, and valve arrangements for pressure regulator assembly.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and details, drawn to scale, on which LPG piping is shown and coordinated with other installations, using input from installers of the items involved.

- B. Site Survey: Plans, drawn to scale, on which LPG piping is shown and coordinated with other services and utilities.

C. Qualification Data: For qualified professional engineer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

- D. Welding certificates.

- E. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For LPG equipment and accessories to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- 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.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing LPG piping according to requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store pipes and tubes with protective PE coating to avoid damaging coating and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

1.10 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Interruption of Existing LPG Service: Do not interrupt LPG service to facilities occupied by Client Agency or others unless permitted under the following conditions and then only after arranging to provide purging and startup of LPG supply according to requirements indicated:
 - 1. Notify Architect and Client Agency no fewer than seven days in advance of proposed interruption of LPG service.
 - 2. Do not proceed with interruption of LPG service without Architect's and Client Agency's written permission.

1.11 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements of "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A53/A53M, black steel, Schedules 40 and 80, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A234/A234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground, and stainless steel underground.
 - 5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
- B. Annealed-Temper Copper Tube: Comply with ASTM B88, Type L.
 - 1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
 - 2. Flare Fittings: Comply with ASME B16.26 and SAE J513.
 - a. Copper fittings with long nuts.
 - b. Metal-to-metal compression seal without gasket.
 - c. Dryseal threads complying with ASME B1.20.3.
 - 3. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch thick.
- C. PE Pipe: ASTM D2513, SDR 11.
 - 1. PE Fittings: ASTM D2683, socket-fusion type or ASTM D3261, butt-fusion type with dimensions matching PE pipe.
 - 2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D2513, SDR 11; and steel pipe complying with ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.

3. Anodeless Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet.
 - b. Casing: Steel pipe complying with ASTM A53/A53M, Schedule 40, black steel, Type E or S, Grade B with corrosion-protective coating covering. Vent casing aboveground.
 - c. Aboveground Portion: PE transition fitting.
 - d. Outlet shall be threaded or flanged or suitable for welded connection.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

4. Transition Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet connected to steel pipe complying with ASTM A53/A53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
 - b. Outlet shall be threaded or flanged or suitable for welded connection.
 - c. Bridging sleeve over mechanical coupling.
 - d. Factory-connected anode.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

5. Plastic Mechanical Couplings, NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Lyall, R. W. & Company, Inc.
 - 2) Mueller Co.
 - 3) Perfection Corporation.
 - b. PE body with molded-in, stainless-steel support ring.
 - c. Buna-nitrile seals.
 - d. Acetal collets.
 - e. Electro-zinc-plated steel stiffener.

6. Plastic Mechanical Couplings, NPS 2 and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1) Lyall, R. W. & Company, Inc.
 - 2) Mueller Co.
 - 3) Perfection Corporation.
 - b. Fiber-reinforced plastic body.
 - c. PE body tube.

- d. Buna-nitrile seals.
- e. Acetal collets.
- f. Stainless-steel bolts, nuts, and washers.

2.2 PIPING SPECIALTIES

A. Flexible Piping Joints:

- 1. Approved for LPG service.
- 2. Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
- 3. Minimum working pressure of 250 psig and 250 deg F operating temperature.
- 4. Flanged- or threaded-end connections to match equipment connected and shall be capable of minimum 3/4-inch misalignment.
- 5. Maximum 36-inch length for liquid LPG lines.

B. Appliance Flexible Connectors:

- 1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
- 2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
- 3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
- 4. Corrugated stainless-steel tubing with polymer coating.
- 5. Operating-Pressure Rating: 0.5 psig.
- 6. End Fittings: Zinc-coated steel.
- 7. Threaded Ends: Comply with ASME B1.20.1.
- 8. Maximum Length: 72 inches

C. Y-Pattern Strainers:

- 1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
- 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
- 3. Strainer Screen: 40-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
- 4. CWP Rating: 125 psig.

D. Basket Strainers:

- 1. Body: ASTM A126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
- 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
- 3. Strainer Screen: 40-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
- 4. CWP Rating: 125 psig.

E. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for LPG.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M.

2.4 MANUAL GAS SHUTOFF VALVES

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. Metallic Valves, NPS 2 and Smaller for Liquid Service: Comply with ASME B16.33 and UL 842.
 - 1. CWP Rating: 250 psig.
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Socket ends for brazed joints.
 - 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 5. Listing by CSA or agency acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 - 6. Valves 1-1/4 inch and larger shall be suitable for LPG service, with "WOG" indicated on valve body.
- C. General Requirements for Metallic Valves, NPS 2 and Smaller for Vapor Service: Comply with ASME B16.33.
 - 1. CWP Rating: 125 psig.
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 - 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 - 6. Service Mark: Valves 1-1/4 inch to NPS 2 shall have initials "WOG" permanently marked on valve body.
- D. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
 - 1. CWP Rating: 125 psig.
 - 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 - 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- E. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. A.Y. McDonald Mfg. Co.
 - b. Apollo Flow Controls; Conbraco Industries, Inc.
 - c. BrassCraft Manufacturing Co.; a Masco company.
 - d. Lyall, R. W. & Company, Inc.
 2. Body: Bronze, complying with ASTM B584.
 3. Ball: Chrome-plated bronze.
 4. Stem: Bronze; blowout proof.
 5. Seats: Reinforced TFE; blowout proof.
 6. Packing: Threaded-body packnut design with adjustable-stem packing.
 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 8. CWP Rating: 600 psig.
 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 10. Service: Suitable for LPG service with "WOG" indicated on valve body.
- F. PE Ball Valves: Comply with ASME B16.40.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Kerotest Manufacturing Corp.
 - b. Lyall, R. W. & Company, Inc.
 - c. Perfection Corporation.
 2. Body: PE.
 3. Ball: PE.
 4. Stem: Acetal.
 5. Seats and Seals: Nitrile.
 6. Ends: Plain or fusible to match piping.
 7. CWP Rating: 80 psig.
 8. Operating Temperature: Minus 20 to plus 140 deg F.
 9. Operator: Nut or flat head for key operation.
 10. Include plastic valve extension.
 11. Include tamperproof locking feature for valves where indicated on Drawings.
- G. Valve Boxes:
1. Cast-iron, two-section box.
 2. Top section with cover with "GAS" lettering.
 3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
 4. Adjustable cast-iron extensions of length required for depth of bury.

5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head and with stem of length required to operate valve.

2.5 MOTORIZED GAS VALVES

A. Automatic Gas Valves: Comply with ANSI Z21.21.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. ASCO Valve Canada; a division of Emerson Electric Canada Limited.
 - b. Dungs, Karl, Inc.
 - c. Eaton.
 - d. Honeywell Building Solutions; Honeywell International, Inc.
2. Body: Brass or aluminum.
3. Seats and Disc: Nitrile rubber.
4. Springs and Valve Trim: Stainless steel.
5. Normally closed.
6. Visual position indicator.
7. Electrical operator for actuation by appliance automatic shutoff device and interlocked with other equipment.

B. Electrically Operated Valves: Comply with UL 429.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. ASCO Valve Canada; a division of Emerson Electric Canada Limited.
 - b. Dungs, Karl, Inc.
 - c. Magnatrol Valve Corporation.
2. Pilot operated.
3. Body: Brass or aluminum.
4. Seats and Disc: Nitrile rubber.
5. Springs and Valve Trim: Stainless steel.
6. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, replaceable.
7. NEMA ICS 6, Type 4, coil enclosure.
8. Normally closed.
9. Visual position indicator.
10. Coordinate all shut-off inter-locks and connections with designated equipment such as fire suppression, ventilation and electrical systems.

2.6 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for LPG.
2. Steel jacket and corrosion-resistant components.

3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Service Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Actaris.
 - b. American Meter Company.
 - c. Fisher Control Valves & Instruments; a brand of Emerson Process Management.
 - d. Invensys.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 100 psig.

C. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Actaris.
 - b. American Meter Company.
 - c. Fisher Control Valves & Instruments; a brand of Emerson Process Management.
 - d. Invensys.
 - e. Maxitrol Company.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet and no pressure sensing piping external to the regulator.

9. Pressure regulator shall maintain discharge pressure setting downstream and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 25 psig or as noted on drawings.

D. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Eaton.
 - b. Harper Wyman Co.
 - c. Maxitrol Company.
 - d. SCP, Inc.
2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: 2 psig or as noted on drawings.

2.7 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. A.Y. McDonald Mfg. Co.
 - b. Capitol Manufacturing Company.
 - c. HART Industrial Unions, LLC.
 - d. Matco-Norca.
 - e. Wilkins.
 2. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 125 psig minimum at 180 deg F.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Matco-Norca.
 - d. Wilkins.
2. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: 125 psig minimum at 180 deg F.
 - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

2.8 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for LPG piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

- A. Comply with requirements in Division 31 for excavating, trenching, and backfilling.

3.3 PREPARATION

- A. Close equipment shutoff valves before turning off LPG to premises or piping section.
- B. Inspect LPG piping according to NFPA 58 and NFPA 54 the International Fuel Gas Code to determine that LPG utilization devices are turned off in piping section affected.

- C. Comply with NFPA 58 and NFPA 54 the International Fuel Gas Code requirements for prevention of accidental ignition.

3.4 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 58 and NFPA 54 the International Fuel Gas Code requirements for installation and purging of LPG piping.
- B. Install underground, LPG piping buried at least 36 inches below finished grade. Comply with requirements in Division 31 for excavating, trenching, and backfilling.
 - 1. If LPG piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. Install underground, PE, LPG piping according to ASTM D2774.
- D. Steel Piping with Protective Coating:
 - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 - 3. Replace pipe having damaged PE coating with new pipe.
- E. Copper Tubing with Protective Coating:
 - 1. Apply joint cover kits over tubing to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
- F. Install fittings for changes in direction and branch connections.
- G. Joints for connection to inlets and outlets on vaporizers, air mixers, regulators, and valves may be flanged or threaded to match the equipment.
- H. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Section 220519 "Meters and Gages for Plumbing Piping."

3.5 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 the International Fuel Gas Code for installation and purging of LPG piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install LPG piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where readily accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- P. Concealed Location Installations: Except as specified below, install concealed LPG piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
 - 1. Above Accessible Ceilings: LPG piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 - 2. In Floors: Install LPG piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
 - 3. In Floor Channels: Install LPG piping in floor channels. Channels must have cover and be open to space above cover for ventilation.

4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
 - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
 5. Prohibited Locations:
 - a. Do not install LPG piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install LPG piping in solid walls or partitions.
- Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- R. Connect branch piping from top or side of horizontal piping.
- S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- T. Do not use LPG piping as grounding electrode.
- U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- V. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Section 2230519 "Meters and Gages for Plumbing Piping."
- W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."
- 3.6 VALVE INSTALLATION
- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
 - B. Install underground valves with valve boxes.
 - C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
 - D. Install anode for metallic valves in underground PE piping.

3.7 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full ID of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 - 2. Bevel plain ends of steel pipe.
 - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Ch. 22, "Pipe and Tube."
- F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for LPG service. Install gasket concentrically positioned.
- G. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.8 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Install hangers for steel piping and copper tubing, with maximum spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Support horizontal piping within 12 inches of each fitting.
- D. Support vertical runs of steel piping and copper tubing to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

- E. Support vertical runs of corrugated stainless-steel tubing to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.9 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install LPG piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliances and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.10 LABELING AND IDENTIFYING

- A. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.11 PAINTING

- A. Comply with requirements in Division 09 for painting interior and exterior LPG piping.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components with factory-applied paint or protective coating.
 - 1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel (semigloss).
 - d. Color: Gray.
- C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components with factory-applied paint or protective coating.

1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex (low sheen).
 - d. Color: Gray or color designated.

- D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.12 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 1. Test, inspect, and purge LPG according to NFPA 58 and NFPA 54 the International Fuel Gas Code and requirements of authorities having jurisdiction.
- C. LPG piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.13 OUTDOOR PIPING SCHEDULE

- A. Aboveground LPG liquid piping shall be one of the following:
 1. NPS 2 and Smaller: Schedule 40 steel pipe, malleable-iron threaded fittings and threaded joints. Coat pipe and fittings with protective coating for steel piping.
 2. NPS 2-1/2 and Larger: Schedule 40, steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
- B. Underground LPG vapor piping shall be the following:
 1. PE pipe and fittings joined by heat-fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
- C. Aboveground LPG vapor piping shall be one of the following:
 1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
 2. Schedule 40, steel pipe with wrought-steel fittings and welded joints, or mechanical couplings.
 3. Annealed or Drawn-temper copper tube, Type L with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
- D. Containment Conduit: Schedule 40, steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.14 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

- A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:
 - 1. Annealed-temper copper tube with wrought-copper fittings and brazed joints.
 - 2. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be one of the following:
 - 1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
 - 2. Schedule 40, steel pipe with wrought-steel fittings and welded joints.
- C. Underground, below building, piping shall be the following:
 - 1. Schedule 40, steel pipe with wrought-steel fittings and welded joints.
- D. Containment Conduit: Schedule 40, steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- E. Containment Conduit Vent Piping: Schedule 40, steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.15 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG

- A. Aboveground, branch piping NPS 1 and smaller shall be one of the following:
 - 1. Annealed-temper copper tube, Type L with wrought-copper fittings and brazed joints.
 - 2. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be one of the following:
 - 1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
 - 2. Schedule 40, steel pipe with steel welding fittings and welded joints.
- C. Underground, below building, piping shall be the following:
 - 1. Schedule 40, steel pipe with wrought-steel fittings and welded joints.
- D. Containment Conduit: Schedule 40, steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.
- E. Containment Conduit Vent Piping: Schedule 40, steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.16 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 5 PSIG

- A. Aboveground Piping: Maximum operating pressure more than 5 psig.

- B. Aboveground, Branch Piping: Schedule 40, steel pipe with steel welding fittings and welded joints.
- C. Aboveground, distribution piping shall be the following:
 - 1. Schedule 40, steel pipe with steel welding fittings and welded joints.
- D. Underground, below building, piping shall be the following:
 - 1. Schedule 40, steel pipe with wrought-steel fittings and welded joints.
- E. Containment Conduit: Schedule 40, steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- F. Containment Conduit Vent Piping: Schedule 40, steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.17 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.
- B. Underground Vapor Piping:
 - 1. PE valves.
 - 2. NPS 2 and Smaller: Bronze, non-lubricated plug valves.

3.18 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Aboveground Liquid Piping:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
- B. Distribution piping valves for pipe NPS 2 and smaller shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
- C. Distribution piping valves for pipe NPS 2-1/2 and larger shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
- D. Valves in branch piping for single appliance shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.

END OF SECTION

SECTION 221127

LIQUID-PETROLEUM GAS SITE DISTRIBUTION

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 DESCRIPTION

- A. The work covered by this Section consists of furnishing all plant, labor, equipment and materials, and performing all operations in connection with the Plumbing Requirements. Excavation and Backfill and Concrete Ballast Pad by General Contractor.
- B. This Section includes the following:
 - 1. Steel pipe and fittings.
 - 2. Pipe specialties, valves, and pressure regulators.
 - 3. Storage containers.
 - 4. Piping.
 - 5. Valves.
- C. Related Sections include the following:
 - 1. Section 221126 "Facility Liquefied-Petroleum Gas Piping" for gas piping inside the building.

1.3 DEFINITIONS

- A. LP: Liquid petroleum.
- B. PE: Polyethylene plastic.

1.4 PERFORMANCE REQUIREMENTS

- A. Working-Pressure Ratings:
 - 1. For Piping Containing Only Vapor:
 - a. Piping and Valves: 125 psig minimum, unless otherwise indicated.

2. For Piping Containing Liquid:
 - a. Piping between Shutoff Valves: 350 psig minimum, unless otherwise indicated.
 - b. Piping Other Than Above: 250 psig minimum, unless otherwise indicated.
 - c. Valves and Fittings: 250 psig minimum, unless otherwise indicated.

1.5 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following:
 1. Storage containers.
 2. Valves.
 3. Regulators. Indicate pressure ratings and capacities.
- B. Shop Drawings: Show fabrication and installation details for storage containers, manifolds. Include plans, elevations, sections, details, and attachments to concrete bases.
 1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Welding certificates.
- D. Manufacturer Seismic Qualification Certification: Submit certification that storage containers, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration Control for HVAC". Include the following:
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For storage containers including relief valves to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of storage containers, manifolds, are based on the specific system indicated.
- B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NFPA 58 for materials, installation, testing, inspection, and purging.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and legally dispose of liquids from drips in existing gas piping. Handle liquids to avoid spillage and ignition. Notify LP-Gas supplier. Do not leave flammable liquids on premises overnight.

1.8 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating services in the area where Project is located.

1.9 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 03300.

PART 2 - PRODUCTS

2.1 JOINTS AND CONNECTIONS

- A. All joints in threaded pipe shall be made with pipe joint compound, lead-free type.
- B. LP gas lines shall be assembled as herein specified.

2.2 PROPANE (LP) GAS SERVICE AND SUPPLY FACILITY

- A. The Plumbing Contractor shall coordinate with LP Gas Supplier and the Department regarding propane gas services for the building.
- B. Furnish and install a fully aboveground ASME LP gas storage tank, as indicated on the drawings, and as herein specified. Tank shall be as manufactured by F.W. Webb, or approved equal. Factory fabricated, horizontal aboveground steel storage tank complying with

requirements in NFPA 58 and ASME Boiler and Pressure Vessel Code and bearing the ASME label. Tanks shall be rated for 250-psig minimum working pressure.

1. Liquid outlet and vapor inlet and outlet connections shall have shutoff valves with excess-flow safety shutoff valves and bypass and back-pressure check valves with smaller than 0.039-inch drill-size hole to equalize pressure. Liquid-fill connection shall have backflow check valve.
 - a. Connections: Color-code and tag valves to indicate type.
 - 1) Liquid fill and outlet, red.
 - 2) Vapor inlet and outlet, yellow.
2. Level gage shall indicate current level of liquid in the container. Gages shall also indicate storage container contents; e.g., "Propane."
3. Pressure relief valves, type and number as required by NFPA 58, connected to vapor space and having discharge piping same size as relief-valve outlet and long enough to extend at least 84 inches directly overhead. Identify relief valves as follows:
 - a. Discharge pressure in psig (kPa).
 - b. Rate of discharge for standard air in cfm (L/s).
 - c. Manufacturer's name.
 - d. Catalog or model number.
4. Container pressure gage.
5. For outdoor installation, exposed metal surfaces mechanically cleaned, primed, and painted for resistance to corrosion.
6. Ladders for access to valves more than 72 inches aboveground.
7. Stainless-Steel Nameplate: Attach to aboveground storage container.
8. Tank Nameplate Information: Name and address of supplier or trade name of container.
 - a. Water capacity in gallons and liters.
 - b. Design pressure in psig (kPa).
 - c. Outside surface area in sq. ft. (sq. m).
 - d. Year of manufacture.
 - e. Shell thickness in inches (mm).
 - f. Overall length in feet (m).
 - g. OD in feet (m).
 - h. Manufacturer's serial number.
 - i. ASME Code label.
9. Felt support pads and two concrete or painted-steel saddles per storage container. Corrosion protection required at container-to-felt contact.
10. Tie straps for each saddle. Straps and anchors for tie-down slab. Asphalt-based coating for corrosion protection.
11. Container connections and valves protected in manway at top of storage container. Manway equipped with ventilation louvers.
12. The Contractor shall furnish and install all required utility rough-in connections, piping, valves, fittings, accessories and components required and recommended by the tank supplier, applicable codes and authorities having jurisdiction to provide a complete,

functioning, safe and approved operating LP gas storage and supply distribution assembly.

13. Arrange the equipment for adequate clearances for maintenance, operation and removal. Coordinate the required size, dimensions and locations of the tank concrete piers, saddles, slab with all clearances and access so fill station, controls and valves are accessible for servicing. Maintain recommended clearances for service and maintenance.
14. All power wiring, electrical outlets, disconnects and components 120 volt and greater, will be included under the Electrical Contract. Advise Electrical Contractor of location and exact location and mounting of equipment and associated equipment control panel(s).
15. The work by the Installing Contractor shall include, but not be limited to, the following:
 - a. Coordinate and assist the LG Gas Supplier with the setting and installation of the LP Gas tank. The Contractor shall furnish and install the structural tank concrete piers, saddles and concrete slab to adequately support the storage tank. Coordinate the required size, dimensions and locations of structural components with the Tank Supplier.
 - b. Provide the required utility installation and final connections for the storage tank equipment. LP Gas piping, vents, valves, relief / safety valves, fill station, electrical and control wiring as required.
 - c. Install LP gas supply distribution piping and associated valves, regulators and fittings to the
 - d. Coordinate and schedule the fill, start-up service and Client Agency operation demonstration. Obtain the assistance and presence of an authorized LP Gas supplier representative.

16. Plumbing Tests:

- a. Test, inspect and purge new gas lines according to NFPA 58 and NFPA 54, the International Fuel gas Code and requirements of local authorities having jurisdiction. Testing method; 30 minutes, minimum. Do not conceal piping until approved testing. All parts shall be adjusted for satisfactory and quiet operation. LPG piping will be considered defective if it does not pass tests and inspections. Prepare test and inspection reports.

C. Tank and regulating equipment will be furnished and installed by the Plumbing Contractor. The Plumbing Contractor shall provide piping to make final connections to primary regulating equipment and shall furnish and install a shutoff cock on inlet and outlet piping of the primary regulator. The Plumbing Contractor shall extend all exterior above ground and below ground gas service piping from the primary regulator outlet valve, to and then within the building.

1. General Requirements:

- a. Single stage and suitable for LPG.
- b. Steel jacket and corrosion-resistant components.
- c. Elevation compensator.
- d. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

2. Service Pressure Regulators: Comply with ANSI Z21.80.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1) Actaris.
 - 2) American Meter Company.
 - 3) Fisher Control Valves & Instruments; a brand of Emerson Process Management.
 - 4) Invensys.
 - b. Body and Diaphragm Case: Cast iron or die-cast aluminum.
 - c. Springs: Zinc-plated steel; interchangeable.
 - d. Diaphragm Plate: Zinc-plated steel.
 - e. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
 - f. Orifice: Aluminum; interchangeable.
 - g. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 - h. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet and no pressure sensing piping external to the regulator.
 - i. Pressure regulator shall maintain discharge pressure setting downstream and not exceed 150 percent of design discharge pressure at shutoff. Overpressure Protection Device: Factory mounted on pressure regulator.
 - j. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
 - k. Maximum Inlet Pressure: 100 psig.
3. Line Pressure Regulators: Comply with ANSI Z21.80.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1) Actaris.
 - 2) American Meter Company.
 - 3) Fisher Control Valves & Instruments; a brand of Emerson Process Management.
 - 4) Invensys.
 - 5) Maxitrol Company.
 - b. Body and Diaphragm Case: Cast iron or die-cast aluminum.
 - c. Springs: Zinc-plated steel; interchangeable.
 - d. Diaphragm Plate: Zinc-plated steel.
 - e. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
 - f. Orifice: Aluminum; interchangeable.
 - g. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 - h. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet and no pressure sensing piping external to the regulator.

- i. Pressure regulator shall maintain discharge pressure setting downstream and not exceed 150 percent of design discharge pressure at shutoff. Overpressure Protection Device: Factory mounted on pressure regulator.
 - j. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
 - k. Maximum Inlet Pressure: 2 psig - 10 psig as indicated per design documents.
4. Appliance Pressure Regulators: Comply with ANSI Z21.18.
- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1) Eaton.
 - 2) Maxitrol Company.
 - 3) SCP, Inc.
 - b. Body and Diaphragm Case: Die-cast aluminum.
 - c. Springs: Zinc-plated steel; interchangeable.
 - d. Diaphragm Plate: Zinc-plated steel.
 - e. Seat Disc: Nitrile rubber.
 - f. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 - g. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
 - h. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
 - i. Maximum Inlet Pressure: 0.5 psig.
- D. All gas equipment furnished and/or installed under this Contract for the gas services shall meet the minimum requirements of ASME, and the National Fire Protection Association as to construction and installation. All work must be installed in accordance with the National Fuel Gas Code (NFPA 54).
- E. Above ground and below ground piping shall be black steel pipe as specified. All screwed piping subject to tank pressure shall be Schedule 80, ASTM A53 Grade B, and screwed fittings thereon to be 3000 lb. forged steel. All welded piping above grade shall be Schedule 40, ASTM A53 Grade B. All underground piping shall be coated and wrapped, API 5L with welded joints. Weld joints on underground lines shall be coated and wrapped, minimum 6" over both directions with materials compatible with coating. Underground lines shall be protected by magnesium anodes. Underground lines shall be weather sealed 1'-0" above grade and separated from above ground piping by insulating fittings. Piping compound shall be approved for LP gas use.
- F. Excavation and backfilling shall be as herein specified. Minimum cover for exterior underground piping shall not be less than 30".
- G. The Contractor shall furnish and install a plastic warning and protective sheet in the gas service trench excavated under this Contract, approximately 1'-0" below finished grade. Plastic sheets shall be specifically designed for utility line protection and warning. Sheets shall be designed for extreme long life, colored orange for gas service, and shall contain continuous black imprinting "Caution Caution Buried Gas Line Below". Imprinting shall be repeated every 24". Plastic sheets shall be furnished in continuous rolls, 6" wide. Plastic sheets shall be Terra Tape,

as manufactured by Reef Industries Division of Griffolyn Company, Inc., Brady Company, Emed Co., Inc., or approved equal.

2.3 TESTING AND ADJUSTING OF SYSTEMS

- A. All testing herein specified shall be applied to new piping and equipment installed under this Contract, except where specifically indicated or specified otherwise.
- B. All split or cracked fittings must be replaced with sound materials and all lines made gastight. Testing may be done in sections to avoid delays to other contractors.
- C. The LP gas storage tank shall have a working pressure of 250 psig @ 105 degrees F.
- D. Propane gas lines from tank to inlet side of primary (first stage) regulator shall be pressure-tested with compressed air or nitrogen at 250 psig.
- E. Propane gas lines beyond the outlet side of the primary (first stage) regulator shall be pressure-tested in accordance with all applicable regulations, but not less than 50 psig.
- F. Soap all threaded connections during pressure tests.
- G. All tests shall be conducted in the presence of the Department, and no pipe lines shall be concealed until approved. All tests shall conform with the requirements of local gas codes and other local or State codes having jurisdiction over the installation.
- H. Minimum time for each test shall be 60 minutes, except where specified or required otherwise.

2.4 PAINTING

- A. The Plumbing Contractor shall furnish all labor, materials, tools, and other equipment necessary for all painting herein specified. All painting shall be done by workmen skilled in this type of work.
- B. All painting herein specified shall be applied to new piping and equipment installed under this Contract, except where specifically indicated or specified otherwise.
- C. Painting shall be performed in strict accordance with the requirements and recommendations of OSHA.
- D. Exposed gas piping and equipment at the exterior of the building, installed under this Contract, shall be painted two coats of Rust-Oleum or equal paint as specified in the preceding paragraphs, except paint shall be of colors selected by the Architect.
- E. All nameplates and data plates that indicate the manufacturer, model, size, capacity, codes or identifying data on equipment painted shall not be painted, but shall be carefully masked and left unpainted.
- F. All painting shall be done in a careful, neat and workmanlike manner. All surfaces shall be thoroughly cleaned of rust, scale, dirt, grease, dust, and like items and sanded so as to provide bond for new paint. This Contractor shall be entirely responsible for cleaning all surfaces and

should evidence appear to the Architect that the surface was not properly prepared, this Contractor shall remove paint, prepare surface, and repaint as required at no additional cost.

- G. Factory finished surfaces which are damaged shall be touched up or repainted to the satisfaction of the Architect.
- H. All painted surfaces under this Contract shall be finished in a manner satisfactory to the Architect.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 312000, "Earth Moving."

3.2 PREPARATION

- A. Close equipment shutoff valves before turning off gas to premises or piping section.
- B. Inspect LP-Gas piping according to NFPA 58 to determine that LP-Gas utilization devices are turned off in piping section affected.

3.3 CONCRETE BASE INSTALLATION

- A. Concrete Bases: Anchor storage containers to concrete base.
 1. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base.
 2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 3. Install anchor bolts to elevations required for proper attachment to supported equipment.
 4. Cast-in-place concrete materials and placement requirements are specified in Section 033000 "Concrete".

3.4 PIPING APPLICATIONS

- A. Flanges, unions, and transition and special fittings with pressure ratings same as or higher than system pressure rating may be used, unless otherwise indicated.
- B. Aboveground Piping: Steel pipe, butt-welding-type fittings, and welded joints. Joints for connection to threaded inlets and outlets on regulators and valves may be threaded.
- C. Aboveground Piping:
 1. NPS 2 and Smaller: Steel pipe, malleable-iron fittings, and threaded joints.
 2. NPS 2-1/2 and Larger: Steel pipe, butt-welding-type fittings, and welded joints. Joints for connection to flanged inlets and outlets on regulators, and valves may be flanged.

Joints for connection to threaded inlets and outlets on regulators, and valves may be threaded.

- D. Underground Piping: PE pipe, PE fittings, and heat-fusion joints. An electrically continuous, corrosion-resistant tracer wire, a minimum of 0.08 inch in diameter, shall be buried with the PE pipe to facilitate locating. One end of wire will run above grade at a building wall or riser. Wire shall not be in direct contact with PE pipe.

3.5 VALVE APPLICATIONS

A. Shutoff-Valve Applications:

1. Underground: Install PE valves.
2. Aboveground: Install ball valves.

B. Hydrostatic Relief-Valve Applications:

1. Install hydrostatic relief valves on piping containing liquid that can be isolated between shutoff valves.
2. Install hydrostatic relief valves to prevent vapor entry into enclosed spaces.
3. Discharge hydrostatic relief-valve vents at least 84 inches above finished grade.
4. Install hydrostatic relief valves to prevent gas service malfunction due to freezing or ice.

3.6 PIPING INSTALLATION

- A. Install underground, LP-Gas distribution piping buried at least 36 inches below finished grade.

- B. Protective Conduit for Underground Piping: Schedule 40 steel pipe with butt-welding-type fittings.

- C. Install underground, PE, LP-Gas distribution piping according to ASTM D 2774.

- D. Drips and Sediment Traps: Install drips at points where condensate may collect. Locate drips and traps where readily accessible to allow cleaning and emptying. Do not install where condensate would be subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

3.7 VALVE INSTALLATION

- A. Install PE shutoff valves on branch connections to underground, LP-Gas distribution piping. Install valves with valve boxes.

- B. Install metal shutoff valves on aboveground, LP-Gas distribution piping.

3.8 PIPE JOINT CONSTRUCTION

- A. Refer to Section 230500, "Common Work Results for HVAC" for basic piping joint construction.

3.9 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect gas distribution piping to LP-Gas source and extend to points indicated. Connect to building's LP-Gas piping. Terminate underground PE piping with service head adapter. Refer to Section 221126, "Facility Liquefied-Petroleum Gas Piping" for LP-Gas piping inside the building.
- C. Install unions in piping NPS 2 and smaller, at final connection to each piece of equipment having threaded pipe connection.
- D. Install flanges in piping NPS 2-1/2 and larger, at final connection to each piece of equipment having flanged pipe connection.
- E. Install aboveground, LP-Gas distribution piping upstream from equipment shutoff valves, electrically continuous, and bonded to grounding electrode. Grounding is specified in Section 260526, "Grounding and Bonding for Electrical Systems."
 - 1. Do not use LP-Gas distribution piping as grounding electrode.
- F. Install piping adjacent to machine to allow service and maintenance.
- G. Ground equipment according to Section 260526, "Grounding and Bonding for Electrical Systems."

3.10 STORAGE CONTAINER INSTALLATION

- A. Fill storage container to at least 80 percent capacity with propane.
- B. Install piping connections with swing joints or flexible connectors to allow for storage container settlement and for thermal expansion and contraction.
- C. Ground containers according to NFPA 780. Grounding is specified in Section 260526, "Grounding and Bonding for Electrical Systems."
- D. Set storage containers in felt pads on concrete or steel saddles. Install corrosion protection at container-to-felt contact.
- E. Install tie-downs over storage containers on saddles with proper tension.
- F. Set concrete saddles on dowels set in concrete base. Anchor steel saddles to concrete base.

3.11 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on or near each storage container and regulator.
 - 1. Text: In addition to identifying unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
- B. Nameplates and signs are specified in Section 220553, "Identification for Plumbing Piping and Equipment."
- C. Warning Tapes: Arrange for installation of continuous, underground, detectable warning tape over LP-Gas distribution piping during backfilling of trenches for piping. Warning tapes are specified in Section 312000, "Earth Moving."

3.12 PAINTING

- A. Paint products and applications are specified in Section 099113, "Painting".
- B. Paint exposed metal piping, valves, regulators, and piping specialties except units with factory-applied paint or protective coating.
- C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.13 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, charge system and test for leaks as required in NFPA 54 and NFPA 58. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry is energized, start units to confirm proper unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning equipment that does not pass tests and inspections and retest as specified above.

3.14 ADJUSTING

- A. Verify and adjust pressure settings for pressure regulators.

3.15 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Department's maintenance personnel to adjust, startup, operate, shutdown, and maintain storage containers with pressure relief valves and pumps.
- B. Include emergency steps that are required when flammable concentrations of liquid or vapor are detected during a full tour of the facility. Also include steps that are required when abnormal conditions occur with pumps.

END OF SECTION

SECTION 221316

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes the following for soil, waste, and vent piping inside the building, extend soil piping to a point 5'-0" beyond the building exterior foundation wall:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.

1.3 DEFINITIONS

- A. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water

1.5 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

- A. All piping materials and installation shall comply with the State of Wisconsin plumbing code and city of Milwaukee ordinance.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

- C. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.
- D. Add cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF International.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service class.
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. ANACO-Husky "2000".
 - b. Clamp-All Corp. "80".
 - c. Mission Rubber Company; a division of MCP Industries, Inc. "Heavyweight".
 - 2. Standards: ASTM C 1277 and ASTM C 1540.
 - 3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 COPPER TUBE AND FITTINGS

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
- B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

- C. Hard Copper Tube: ASTM B 88, Type L and Type M, water tube, drawn temper.
- D. Copper Pressure Fittings:
 - 1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- E. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 - 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- F. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.5 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- C. Adhesive Primer: ASTM F 656.
 - 1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive primer 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. Solvent Cement: ASTM D 2564.
 - 1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Solvent cement 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 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 - 1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
 - 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

3. Shielded, Non-pressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1) Cascade Waterworks Mfg. Co.
 - 2) Mission Rubber Company; a division of MCP Industries, Inc.
 - b. Standard: ASTM C 1460.
 - c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Flanges:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1) Capitol Manufacturing Company.
 - 2) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 3) Wilkins; a Zurn company.
 - b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Factory-fabricated, bolted, companion-flange assembly.
 - 3) Pressure Rating: 125 psig minimum at 180 deg F.
 - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
3. Dielectric-Flange Insulating Kits:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1) Advance Products & Systems, Inc.
 - 2) Calpico, Inc.
 - 3) Pipeline Seal and Insulator, Inc.
 - b. Description:
 - 1) Non-conducting materials for field assembly of companion flanges.
 - 2) Pressure Rating: 150 psig.
 - 3) Gasket: Neoprene or phenolic.
 - 4) Bolt Sleeves: Phenolic or polyethylene.
 - 5) Washers: Phenolic with steel backing washers.

4. Dielectric Nipples:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:

- 1) Elster Perfection.
- 2) Grinnell Mechanical Products.
- 3) Precision Plumbing Products, Inc.
- 4) Victaulic Company.

b. Description:

- 1) Standard: IAPMO PS 66
- 2) Electroplated steel nipple.
- 3) Pressure Rating: 300 psig at 225 deg F.
- 4) End Connections: Male threaded or grooved.
- 5) Lining: Inert and noncorrosive, propylene.

2.7 ENCASEMENT FOR UNDERGROUND METAL PIPING

- A. Standard: ASTM A 674 or AWWA C105/A 21.5.
- B. Material: High-density, cross-laminated polyethylene film of 0.004-inch minimum thickness.
- C. Form: Sheet or tube.
- D. Color: Black.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install fittings for changes in direction and branch connections.
- C. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side

with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

- D. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- E. Install soil and waste drainage and vent piping at slopes per applicable codes.
- F. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- G. Install underground PVC piping according to ASTM D 2321.
- H. Install force mains at elevations indicated.
- I. Plumbing Specialties:
 - 1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 Section "Sanitary Waste Piping Specialties."
 - 2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Sanitary Waste Piping Specialties."
- J. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- K. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- L. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- M. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.
- C. Plastic, Non-pressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 - 2. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 3. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 - 4. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 5. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support horizontal piping and tubing within 12 inches of each fitting and coupling.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4 and NPS 2: 60 inches with 3/8-inch rod.
 - 2. NPS 3: 60 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 - 4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
 - 5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- F. Install supports for vertical cast-iron soil piping every 15 feet.

- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 84 inches with 3/8-inch rod.
 - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 - 3. NPS 2: 10 feet with 3/8-inch rod.
 - 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 - 5. NPS 3: 12 feet with 1/2-inch rod.
 - 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 - 7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
- H. Install supports for vertical steel piping every 15 feet.
- I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 3. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
- J. Install supports for vertical copper tubing every 10 feet.
- K. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4, NPS 1-1/2 thru NPS 2: 48 inches with 3/8-inch rod.
 - 2. NPS 3: 48 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 - 4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
- L. Install supports for vertical PVC piping every 48 inches.
- M. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
 - 1. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Comply with requirements for cleanouts and drains specified in Division 22 Section "Sanitary Waste Piping Specialties."

- D. Connect force-main piping to the following:
 - 1. Sanitary Sewer: To exterior force main.
- E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- F. Make connections according to the following unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.6 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 6. Prepare reports for tests and required corrective action.
- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 4. Prepare reports for tests and required corrective action.

3.8 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.9 PIPING APPLICATION SCHEDULE

- A. General:
 1. NO PVC PIPING SYSTEMS SHALL BE INSTALLED IN DESIGNATED RETURN AIR PLENUM AREAS OR SPACES. Install only the specified metallic piping and fittings for all sanitary, waste and vent piping systems located in this designated area or space. No PVC, CPVC or associated plastic piping will be accepted or approved for the designated plenum areas. Plenum wrap insulation will not accepted as an alternative for metallic piping in plenum area installations.
 2. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

- B. Underground, soil, waste, and vent piping NPS 6 and smaller shall be any of the following:
1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
 2. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 3. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.
- C. Aboveground soil and waste piping NPS 6 and smaller shall be any of the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; hubless-piping couplings; and coupled joints.
 3. Copper DWV tube, copper drainage fittings, and soldered joints.
 4. PVC pipe, PVC socket fitting and solvent-cemented joints.
 5. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.
- D. Aboveground vent piping NPS 6 and smaller shall be any of the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
 3. Copper DWV tube, copper drainage fittings, and soldered joints.
 - a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M, copper pressure fittings, and soldered joints.
 4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 5. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.
- E. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 shall be any of the following:
1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 2. Galvanized-steel pipe, pressure fittings, and threaded joints.
- F. Aboveground, condensate drainage piping NPS 3 and smaller shall be any of the following:
1. Hubless, cast-iron soil pipe and fittings; hubless-piping couplings; and coupled joints.
 2. Copper DWV tube, copper drainage fittings, and soldered joints.
 - a. Option for Condensate Piping, NPS 2 and larger: Hard copper tube, Type M, copper pressure fittings, and soldered joints.
 3. PVC pipe, PVC socket fitting and solvent-cemented joints.
 4. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

END OF SECTION

SECTION 221319

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes the following sanitary drainage piping specialties:
 - 1. Cleanouts.
 - 2. Roof flashing assemblies.
 - 3. Through-penetration firestop assemblies.
 - 4. Miscellaneous sanitary drainage piping specialties.
 - 5. Flashing materials.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:
 - 1. Floor drains.
- B. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Cleanout Types: Floor level cleanouts; wall cleanouts.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - b. Watts Drainage Products Inc.
 - c. Zurn Plumbing Products Group; Specification Drainage Operation.
- B. Description: Cast iron with bronze plug and polished nickel-bronze top.
- C. Appropriate Standard: ASME A112.36.2.
- D. Material: Cast-iron body.
- E. Shape: Round.
- F. Top-Loading Classification: Medium Duty.
- G. Cover Finish: Polished nickel-bronze.
- H. In-Line Above Floor Cleanouts: Plugs in wye fittings.

- I. Interior Cleanouts: For floor level cleanouts, similar to Zurn No. ZN-1400-KC-SC, or equal. Cleanouts in walls, similar to Zurn No. Z-1445, or equal. Cleanouts in carpeting, Zurn No. ZN-1400-KC-CM-SC, or equal. Access covers, similar to Zurn No. ZANB-1460 cover and frame, or equal. Copy and edit paragraph and subparagraphs below for each type of metal floor cleanout required. If only one type is required, drawing designation may be omitted.

2.2 SANITARY DRAIN ASSEMBLIES

- A. Refer to Section 221320 Sanitary Drains for Floor Drains, Trench Drains, Floor Sinks and associated fittings.
- B. Refer to the Plumbing Floor Drain Schedule on Plumbing drawings for the designated Floor Drain number, type, application, location, basis of design and additional information.

2.3 ROOF FLASHING ASSEMBLIES

- A. Roof Flashing Assemblies:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Acorn Engineering Company; Elmdor/Stoneman Div.
 - b. Thaler Metal Industries Ltd.
 - B. Description: Manufactured assembly made of 4.0-lb/sq. ft. thick, copper flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
 1. Open-Top Vent Cap: Without cap.
 2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
 3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Air-Gap Fittings:
 1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
 2. Body: Bronze or cast iron.
 3. Inlet: Opening in top of body.
 4. Outlet: Larger than inlet.
 5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.
- B. Sleeve Flashing Device:
 1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top

of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.

2. Size: As required for close fit to riser or stack piping.

C. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

D. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.5 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft..
2. Vent Pipe Flashing: 8 oz./sq. ft..

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
- F. All cleanouts on piping runs of 40 feet or longer shall have a rodding tee (double flow tee) rather than a single direction sweeping tee. This shall allow rodding in either direction.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- G. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- H. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- I. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.
- J. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- K. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

- L. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- M. Install wood-blocking reinforcement for wall-mounting-type specialties.
- N. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- O. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

- A. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- B. Set flashing on floors and roofs in solid coating of bituminous cement.
- C. Secure flashing into sleeve and specialty clamping ring or device.
- D. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."
- E. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- F. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 221320
SANITARY DRAINS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Floor drains.
 - 2. Funnel drains.
 - 3. Miscellaneous drain specialties.
 - 4. Trap seals.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 FLOOR DRAIN ASSEMBLIES

- A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Company.
 - c. Wade; a subsidiary of McWane Inc.
 - d. Zurn Industries, LLC.
 - 2. Standard: ASME A112.6.3 with backwater valve.
 - 3. Pattern: Area, Floor and Funnel floor drain.
 - 4. Body Material: Gray iron.
 - 5. Seepage Flange: As required.
 - 6. Anchor Flange: As required.
 - 7. Outlet: Bottom or Side as designated.

8. Sediment Bucket: Yes.
9. Top or Strainer Material: Gray iron, Nickel bronze or stainless as designated.
10. Top of Body and Strainer Finish: Nickel bronze or Stainless steel.
11. Top Shape: Round.
12. Top Loading Classification: Provide Traffic - Heavy Duty top at designated location where the drain may be subject to vehicular traffic, such as parking garage.
13. Funnel: As required or designated.
14. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection where required.
15. Trap Material: Cast iron.
16. Trap Pattern: Deep-seal P-trap.
17. Trap Seal Feature: Water-supplied trap-seal primer valve and supply connection or trap-seal insert were designated and required.
 - a. Provide only trap seal inserts for drains at locations that are subject to freezing.

2.2 TRENCH DRAINS

- A. Cast-Iron Trench Drains (TD-#): Refer to the Plumbing Floor Drain Trench Drain Schedule on Plumbing drawings for the designated Trench Drain number, type, application, location, basis of design and additional information.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Company.
 - c. Wade; a subsidiary of McWane Inc.
 - d. Zurn Industries, LLC.
 2. Description: Heavy Duty Cast Iron - Garage Floor Drain with cast iron grate top drain.
 3. Appropriate Standard: ASME A112.21.1.
 4. Pattern: Square – Rectangular Trench drain.
 5. Body Material: Stainless steel.
 6. Anchor Flange: As required.
 7. Clamping Device: As required.

2.3 FUNNEL DRAINS

- A. 6" x 4" or 4" x 2" Funnel Drains: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section of length to provide depth indicated; and where indicated, increaser fitting of size indicated, joined with ASTM C 564 rubber gaskets. Size P-trap as indicated.

2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch- minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

2.5 TRAP SEAL INSERTS

A. Trap Guard/ Seal Inserts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Sure Seal Manufacturing
 - b. Jay R. Smith Mfg. Co.
2. Furnish and install a trap-guard/ seal insert made of elastomeric material on all floor drains and funnel drains located within the interior of the building unless otherwise specified. The size shall match the specified floor drain or funnel drain type and outlet piping. The trap guard/ seal insert provides an alternative trap protection application and prohibits sewer gases from entering the building space in the event that the trap seal is compromised while allowing wastewater to adequately discharge through the drain.
3. Sure Seal is ASSE 1072 approved listing #1409 and IAMPO listed C-4165.
4. Quad Close Trap Seal – Jay R. Smith Mfg. Co. Model #2692 - ASSE 1072 approved listing and tested and Certified by IAMPO R&T.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 1. Position floor drains for easy access and maintenance.
 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.

3. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
 - a. Maintain integrity of waterproof membranes where penetrated.
 5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- B. Install trench drains at low points of surface areas to be drained.
1. Set grates of drains flush with finished surface, unless otherwise indicated.
- C. Comply with ASME A112.3.1 for installation of stainless-steel channel drainage systems.
1. Install on support devices, so that top will be flush with adjacent surface.
- D. Install open drain fittings with top of hub 2 inches above floor.
- E. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- F. Install trap seal inserts on drains that require trap seal inserts.

3.2 CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements in Section 221319 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.
- C. Comply with requirements in Section 221323 "Sanitary Waste Interceptors" for grease interceptors, grease-removal devices, oil interceptors, sand interceptors, and solid interceptors.
- D. Install piping adjacent to equipment to allow service and maintenance.
- E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 LABELING AND IDENTIFYING

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 223400

HIGH EFFICIENCY TANKLESS GAS DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes packaged, factory-fabricated and assembled, gas-fired, high efficiency condensing domestic water heaters, trim and accessories for generating hot potable water.

1.3 SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties and accessories.
- B. Pressure Drop Curve: Submit pressure drop curve for flows ranging from 0 GPM to maximum value of water heater.
- C. Shop Drawings: For water heaters, water heater trim and accessories, include:
 - 1. Elevations, sections, details
 - 2. Wiring Diagrams for power
- D. Operation and Maintenance Data: Data to be included in water heater emergency, operation and maintenance manuals.
- E. Warranty: Standard warranty specified in this Section.
- F. Made in America Certification
- G. Other Informational Submittals.
 - 1. ASME Stamp Certification and Report

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Condensing water heaters must be constructed in accordance with ASME Water heater and Pressure Vessel Code, Section IV (HLW) Potable Water Heaters.

- B. ETL Compliance. Condensing water heaters must be tested for compliance with ETL , "Commercial-Industrial Gas Heating Equipment." Condensing water heaters shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- C. CO Emission Standards. When installed and operated in accordance with manufacturer's instructions.

1.5 COORDINATION

- A. Coordinate the exact size and location of wall mounted water heater units and associated wall mounting brackets with the wall structure with actual equipment provided.
- B. Coordinate the exact dimensions and layout requirements of multiple water heater units with the space provided.
- C. Coordinate the exact dimensions, location, clearances and weight requirements of the water heaters furnished to determine and provide adequate structural supports, attachments, bracing and blocking for wall mounting units.
- D. Coordinate the exhaust venting and combustion air intake piping system requirements and recommendations of the water heater manufacturer. Confirm the exhaust and intake piping type, material, configuration, length, number of fittings, and sizing is acceptable to the water heater manufacturer, and is full compliance with the appliance's UL listing and the appliance manufacturer's recommendations.

1.6 PERFORMANCE REQUIREMENTS AND CONDITIONS:

- A. The domestic hot water heating system design represented by the Contract Documents has been based upon the performance characteristics and construction parameters of the selected "Basis of Design" make and model water heating system equipment assembly.
- B. System Configuration, Location and Space: The designated location of the domestic hot water heating system shall be coordinated to accommodate the designated space for all associated components, accessories, pumps, utility manifold piping, valves and fittings with all required clearances and accessibility dimensions provided.

1.7 WARRANTY

- A. Standard Warranty: Water heaters shall include manufacturer's standard form in which manufacturer agrees to repair or replace components of water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Condensing Water heaters: The heat exchanger coil shall carry a 10 year from commissioning, non-prorated, limited warranty against any failure due to waterside corrosion, mechanical defects, or workmanship. The heat exchanger coil shall carry a 10 year from commissioning, non-prorated, limited warranty against any failure due to condensate corrosion, thermal stress, mechanical defects, or workmanship.

2. Manufacturer labeled control panels are conditionally warranted against failure for two (2) years from commissioning.
3. All other components, including the electronic igniter and electrode, are conditionally guaranteed against any failure for 24 months from commissioning.
4. Optional extended service for manufacturer to provide factory monitoring of water heater performance and parts via wi-fi or 3G/4G hub. Factory prognostics and predictive maintenance in the optional service.

B. Compression (Thermal Expansion) Tanks: Five years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
1. Intellihot Inc.
 2. Rannai.
 3. Navian.

2.2 CONSTRUCTION

- A. General: The domestic water heating plant shall consist of 2 wall mounted commercial heaters to supply the building with 120°F hot water. Each water heater system shall be connected to a common piping manifold and connect to operate by a masterless cascading control system. The water heaters shall be ETL Listed; ASME Section IV (HLW) coded and stamped and shall incorporate a negative Pressure gas valve on each exchanger capable of full fire operation at of 2.5" WC of Gas pressure. Each unit shall achieve a minimum turn down 8.3 per 250,250 BTU of input. The total water content in the system shall be less than 2 Gallons per 250,250 BTU/hr of input. (Refer to Plumbing Drawings for additional information, location, piping diagrams and associated details.)
- B. Basis of Design 120°F Building Water Heater Assembly: Two (2) wall/ mounted, manifold connected units: Each water heater shall be Intellihot Model iQ251, Gen II with an input of 251 MBH, output of 241 MBH, 6.0 GPM at 80°F rise – 10.7 GPM at 45°F when fired with natural gas, Outlet temperatures set at 120°F, turndown ratio 8.3:1, CO emissions of less than 400 ppm. Each Unit has one 250,250 Btu Heat Exchanger.
- C. Description: Water heater shall be direct fired, fully condensing, water-tube design. Power burner shall have full modulation. The minimum firing rate shall not exceed 30,000 BTU/HR input. Water heaters that have an input greater than 30,000 BTU/Hr at minimum fire will not be considered equal. The water heater shall have the capability of discharging into a positive pressure vent. Water heater thermal efficiency shall increase with decreasing load (output), while maintaining set point. Water heater shall have an operational set point capability of 100 °F to 190 °F and shall maintain the outlet temperature within an accuracy of +/- 4 °F during load changes of up to 30% rated capacity. Water heater shall be factory-fabricated, factory-assembled and factory-tested, water-tube condensing water heater with heat exchanger sealed pressure-tight,

built on a steel base, including a sealed insulated sheet metal enclosure that acts as combustion-air intake plenum with a built in serviceable air filter

- D. Heat Exchanger: The heat exchanger shall be constructed with 316L stainless steel helical water tube, fully floating with no welded joints in the exchanger. The exchanger will have a single-pass unitary design (no separate primary and secondary heat exchanger). The water tubes shall be 0.75" ID, with no less than 0.0472" wall thickness. The heat exchanger shall be ASME Sect IV (HLW) stamped for a working pressure not less than 160 psig.
- E. Modulating Air/Fuel Valve and Burner: The water heater burner shall be capable of a - 8.3 to 1 turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves. The burner shall be stainless fiber mesh covering a stainless steel body with spark ignition and flame rectification. All burner material exposed to the combustion zone shall be of stainless steel construction. There shall be no moving parts within the burner itself. A modulating air/fuel valve shall meter the air and fuel input. A variable frequency drive (VFD), controlled pre-mix blower shall be used to ensure the optimum mixing of air and fuel between the air/fuel valve and the burner.
- F. The exhaust manifold for multiple water heater units shall be of polypropylene with 6" diameter flue connection. Refer
- G. Ignition: Ignition shall be via spark ignition with 100 percent main-valve shutoff and dual electronic flame supervision.

2.3 CONTROLS

- A. The water heater control system shall be a Masterless Cascading design with no-master - slave designation. The entire system shall have built-in usage optimization routine.
- B. The water Heaters shall be furnished with the manufacturers BMS (BacNET/ Modbus) "iNTouch" control modules and "telliZero" WiFi enabled services for remote monitoring and control. The service provides prognostics and predictive maintenance and 24/7/ 365 monitoring by factory personnel which can assist to take appropriate corrective action in the event of a problem.
- C. The control panel shall consist of one individual circuit. The circuit boards shall include:
 - 1. A Digital touch display to indicate temperature and status
 - 2. A CPU board housing all control functions
 - 3. Each board shall be individually field replaceable.
- D. The combustion safeguard/flame monitoring system shall use spark ignition and a rectification-type flame sensor.
- E. The unit shall have a selectable exhaust temperature limit suitable for venting with Polypropylene.
- F. The controls shall annunciate water heater and sensor status and include extensive self-diagnostic capabilities.

1. Set point High Limit: Set point high limit allows for a selectable maximum water heater outlet temperature and acts as temperature limiting governor. Set point limit is based on a closed loop function that automatically limits firing rate to maintain outlet temperature.
- G. The water heater control system shall incorporate the following additional features for enhanced external system interface:
1. Temperature set point
 2. High Exhaust temp monitor and control. Turn down the Gas valve until the exhaust temp is kept below selected material (Polypropylene).
 3. Cascading via RS232
 4. Error Code Display / Error Code History
 - a. Blower Fault
 - b. Blocked Flue Fault
 - c. Ignition Failure
 - d. Temp Sensor Short
 - e. Temp Sensor Wiring Fault
 - f. Flue Temp Fault
 - g. Heat Exchanger Temp Fault
 - h. Cascading Fault
 - i. Water Valve Fault
 - j. Pump Fault
 - k. Software Fault
 5. Monitor and access to daily, weekly, monthly water usages data.
 6. Monitor inlet/outlet temperatures, flow rates, flue gas temperatures, combustion rates via onboard touchscreen and via IoT app.
 7. Water Heater Management: the water heater control system shall incorporate onboard multi-unit sequencing logic that would allow Masterless Cascading (Not Lead/Lag) functionality & sequencing between multiple water heaters operating in parallel and must have the following capabilities:
 - a. Efficiently sequence 2 up to 16 (4,000,000 Btu) heat exchangers on the same system to meet the load requirement.
 - b. Individual heat exchanger logic to enable accurate temperature control.
 - c. Operate one motorized valve per heat exchanger as an element of the load sequencing, Valves shall close with decreased load as heaters turn off, minimum of one (depending upon Mode selection) must always stay open for recirculation.
 - d. Automatically rotate Start/Stop amongst the heat exchangers in the chain based upon an internal calculation of run hours, water through put, burner starts and stops and length of time each burner has been firing. Sequencing is not based upon next in line (Lead/Lag), it is based upon the most logical (least used) heat exchanger in an effort to equalize unit run hours.
 - e. Automatic bump-less transfer of sequencing in case of heat exchanger failure. All systems must be able to fail all but one heat exchanger in any order or for any reason and the last will continue to operate.
 - f. Each heat exchanger will default to individual control upon failure of the sequencing chain.
 - g. Automatic isolation of heat exchanger module from water circuit in case of failure and prevention of cold water from exiting the system

- h. Masterless control, change any parameter in any one of the units and all the rest in the series will automatically adjust to the most recent parameter change.

2.4 ELECTRICAL POWER

- A. Controllers, Electrical Devices and Wiring: Electrical devices and connections are specified in Division 26 sections.
- B. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers and other electrical devices shall provide a single-point field power connection to the water heater.
- C. Electrical Characteristics:
 - 1. Voltage: 120 V
 - 2. Phase: Single
 - 3. Frequency: 60 Hz
 - 4. Full-Load Current 5 Amps or less per 251,000 BTU of heat input

2.5 WATER HEATER EXHAUST VENT AND COMBUSTION AIR INTAKE PIPING:

- A. Exhaust Venting: Piping shall be UL listed for positive pressure, condensing flue gas. Furnish install schedule 40 Polypropylene (PP) with associated fittings, transitional size fittings, and exhaust vent roof terminal with insect screen cover fitting.
- B. Combustion Air Intake: Piping shall be schedule 40 Polypropylene (PP) with associated fittings, transitional size fittings, Intake air roof terminal and insect screen cover fitting.
- C. Polypropylene Piping Systems:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Centrotherm Eco Systems – "InnoFlue Commercial"
 - b. DuraVent, M&G Group - "PolyPro"
 - c. Selkirk – "Polyflue"
 - d. Z-Flex, Novaflex Inc. – "Z-Dens"
 - 2. Description: ULC S636 listed as a Type BH - Class IIC gas venting system, in sizes from 2" to 12", and rated for a continuous maximum flue gas temperature of 230 deg. F., with positive flue pressure as high as 15" w.c. Provide pipe, vent terminal, supports, drain and test port fittings, appliance connectors, thimble, condensate trap, sealant, and all other required accessories. System shall be suitable for use with Category II and IV heating equipment (as defined by NFPA 54 / ANSI Z223.1) where accepted by the equipment manufacturer. (Refer to Plumbing Drawings for additional information, location piping diagrams and details.)
 - 3. Construction: Single wall, 3mm thick polypropylene, with EPDM or Viton gasketed joints. Gasket material shall be approved by the appliance manufacturer. Polymer for portions of

the system installed outdoors shall be UV stabilized and fully suitable for exterior use without additional protection or applied coatings.

4. Required Clearance to Combustibles: Zero, concealed or unconcealed, horizontal or vertical, throughout the size range offered, with a sustained maximum flue gas temperature of 230 deg F.
5. Accessories: Appliance connectors, tees, elbows, increasers, termination, drain fittings, wall flashing, storm collar, support assembly, thimbles, firestop spacers, and fasteners; fabricated of similar materials and designs as vent-pipe straight sections.
 - a. Vent and Intake Air Termination: Round termination designed to exclude minimum 98 percent of rainfall. Furnish Complete roof penetration terminal system, non-corrosive UV resistant, pipe and vent terminal, thimble, indoor sealing plate, piping sleeve and seal adapter
6. Low Point Drain Connections: Provide condensate drain connection fittings at low points in exhaust vent and air intake piping system. Connect and extend condensate drainage tubing with trap and terminate into neutralizing drainage system.

2.6 CONDENSATE

- A. Condensate traps, manufactured from only non-corrosive materials.
- B. Optional Accessory: Smart condensate neutralizer with capability of monitoring pH levels through included IoT app. Smart Neutralizer to also include
 1. Monitor water temperatures
 2. CO detection, flue gas detection, water leak detection of boiler room w/ audible/visual alarms and alerts via app.
 3. Water flow recording/monitoring
 4. View history of above parameters via app.

2.7 CONDENSATE DRAINAGE NEUTRALIZING SUMP MEDIA FILTER AND PIPING:

- A. Condensate Neutralizing Interceptors:
 1. Description: Condensate drainage waste interceptor sump or canister with neutralizing media: Furnish and install condensate drain neutralizing sump or sump canister with acid neutralizing media on the condensate drainage discharge line prior to terminating discharge into the building drainage system.
 2. Large Capacity - Condensate Neutralizing Interceptors:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1) Orion Fittings; a Watts Water Technologies company.
 - 2) Schier Products Company.
 - 3) Town & Country Plastics, Inc.
 - 4) Zurn Industries, LLC.

- b. Neutralizing Interceptor Description: Corrosion-resistant plastic tank or cartridge filled with acid neutralizing media; with removable, serviceable gastight cover; inlet and outlet; hub or threaded, top or sidewall pipe connections.
 - 1) Basis of Design: Schier Products – Model#LB-2 or Zurn / Green Turtle- Phix Cartridge System.
 - 2) Material: HDPE or ASTM D 4101, PP.
 - 3) Tank Capacity: 2 gallon capacity.
 - 4) Retain one or both of first two subparagraphs below if required.
 - 5) Dip Tube: On outlet pipe instead of inlet pipe.
 - 6) Extension: HDPE, PE, or PP.
 - 7) Retain one of two subparagraphs below. Retain second for chemical wastes with high sulfuric acid content.
 - 8) Limestone: Chips or lumps, with more than 90 percent calcium carbonate content and 1- to 3-inch diameter.
 - 9) Neutralizing Media: Dolomitic Limestone Chips or pellets, with more than 90 percent combined magnesium carbonate and calcium carbonate content and 1- to 3-inch diameter or as recommended by the manufacturer.
- c. Inlet and Outlet Size: 2".
- d. End Connections: Hub or Threaded.
- e. Mounting: Above floor structural supported and anchored with corrosive resistant frame, cradle or straps.
- f. Descriptive Type or Function: High Efficiency Condensing Type Water Heating System Condensate drainage treatment.

B. Condensate drainage corrosive resistant tubing, piping and associated fittings:

- 1. Exhaust Vent Low Point Condensate Drain Connections: Provide condensate drain connection fittings at all low points in exhaust vent and air intake piping system. Connect and extend condensate drainage tubing with trap and terminate into neutralizing drainage system.

2.8 VENTING

- A. The exhaust vent must be Polypropylene compatible with positive pressure, condensing flue gas service.
- B. The minimum exhaust vent duct size for each water heater is six-inch diameter.
- C. Combustion-Air Intake: Water heaters shall be capable of drawing combustion air from the outdoors via a Polypropylene vent duct connected between the water heater and the outdoors.
- D. The minimum sealed combustion air intake and exhaust vent size for each water heater is 3” diameter and the minimum common manifold size is 6" diameter or as otherwise noted.
- E. Common Vent and Common Combustion Air for multiple units. Consult manufacturer for common invent piping arrangement and combustion air sizing.

2.9 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions and carbon monoxide in flue gas, and to achieve combustion efficiency.
- B. Live-fire Test and inspect factory-assembled water heaters, before shipping.
- C. Allow Client Agency access to source quality-control testing of water heaters.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before water heater installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations. Examine piping and electrical connections to verify actual locations, sizes and other conditions affecting water heater performance, maintenance and operations.
 - 1. Final water heater locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where water heaters will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WATER HEATER INSTALLATION

- A. Install water heaters level on concrete bases. Concrete base is specified in Division 22 Section "Common Work Results for Plumbing," and concrete materials and installation requirements are specified in Division 03.
- B. Install gas-fired water heaters in accordance with:
 - 1. Local, states, provincial and national codes, laws, regulations, and ordinances.
 - 2. National Fuel Gas Code, ANSI Z223.1/NFPA 54 – latest edition.
 - 3. National Electrical Code, ANSI/NFPA 70 - latest edition.
 - 4. Canada only: CAN/CGA B149 Installation Code and CSA C22.1 CEC Part 1.
 - 5. Manufacturer's installation instructions, including required service clearances and venting guidelines.
- C. Assemble and install water heater trim.
- D. Install electrical devices furnished with water heater but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 sections. Drawings indicate general arrangement of piping, fittings and specialties.
- B. Install piping adjacent to water heater to permit service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect gas piping to water heater gas valve with unions. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- E. Connect hot-water piping to supply and return water heater tapplings with shutoff valve and union or flange at each connection.
- F. Multiple heaters shall be piped such that all cold water entering the system will go through the heat exchanger first. A series of approved piping installation examples are shown in the installation and maintenance manuals provided with the unit. Each water heater shall have individual isolation valves for servicing and a hot water hose connection for start-up and field testing.
- G. Install piping from safety relief valves to nearest floor drain.
- H. Water heater Venting
 - 1. Install flue venting kit and combustion-air intake.
 - 2. Connect venting full size to water heater connections.
- I. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- J. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections
 - 1. Installation and Startup Test: Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Leak Test: Perform hydrostatic test. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion, if necessary.

4. Controls and Safeties: Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Occupancy Adjustments: When requested within 2 months of date of Substantial Completion, provide on-site assistance adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.
- E. Performance Tests
- F. The water heater manufacturer is expected to provide partial load thermal efficiency curves. These thermal efficiency curves must include at least three separate curves at various BTU input levels. If these curves are not available, it is the responsibility of the water heater manufacturer to complete the following performance tests:
 1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
 2. Water heaters shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
 3. Perform field performance tests to determine capacity and efficiency of water heaters.
 - a. Test for full capacity.
 - b. Test for water heater efficiency at low fire, 20, 40, 60, 80 and full capacity. Determine efficiency at each test point.
 4. Repeat tests until results comply with requirements indicated.
 5. Provide analysis equipment required to determine performance.
 6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
 7. Notify Architect in advance of test dates.
 8. Document test results in a report and submit to Architect.

END OF SECTION

SECTION 224000
PLUMBING FIXTURES

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes plumbing fixtures and trim, faucets, other fittings, and related components.

1.3 DEFINITIONS

- A. Accessible: Plumbing fixture, building, facility, or portion thereof that can be approached, entered, and used by physically handicapped, disabled, and elderly people.
- B. Fitting: Device that controls flow of water into or out of plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads, drains and tailpieces, traps and waste pipes. Pipe fittings, tube fittings, and general-duty valves are included where indicated.

1.4 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract.
- B. Product Data for each plumbing fixture category and type specified. Include selected fixture, trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- C. Wiring diagrams from manufacturer for electrically operated units.
- D. Maintenance data for plumbing fixtures and components to include in the operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category from one source and by a single manufacturer.

1. Exception: Where fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for this category.
 - B. Regulatory Requirements: Comply with requirements of CABO A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; regarding plumbing fixtures for physically handicapped people.
 - C. Energy Policy Act Requirements: Comply with requirements of Public Law 102-486, "Energy Policy Act," regarding water flow rate and water consumption of plumbing fixtures.
 - D. Listing and Labeling: Provide electrically operated fixtures and components specified in this Section that are listed and labeled.
 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
 - E. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
 - F. Product Options: Drawings indicate size, profiles, dimensional requirements, and characteristics of plumbing fixtures and are based on specific types and models indicated. Other manufacturers' fixtures with equal performance characteristics may be considered.
- 1.6 DELIVERY, STORAGE, AND HANDLING
- A. Deliver plumbing fixtures in manufacturer's protective packing, crating, and covering.
 - B. Store plumbing fixtures on elevated platforms in dry location.
- 1.7 PROJECT CONDITIONS
- A. Field Measurements: Coordinate roughing-in and final fixture locations and verify that plumbing fixtures can be installed to comply with original design and referenced standards.
- 1.8 EXTRA MATERIALS
- A. Deliver extra materials to Using Agency. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
 1. Faucet Washers and O-Rings: Furnish quantity of identical units not less than 10 percent of each type and size installed.
 2. Faucet Cartridges and O-Rings: Furnish quantity of identical units not less than 5 percent of each type and size installed.

3. Faucet, Laminar-Flow Fittings: Furnish quantity of identical units not less than 10 percent of each type and size installed.
4. Flushometer Valve, Repair Kits: Furnish quantity of identical units not less than 10 percent of each type installed.
5. Provide hinged-top, wood or metal box, or individual metal boxes, having separate compartments for each type and size of extra materials listed above.
6. Toilet Seats: Furnish quantity of identical units not less than 5 percent of each type installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide plumbing fixtures and accessories in compliance with the following requirements:

1. Furnish and install plumbing fixtures, of types as scheduled on the drawings. Furnish and install rough-in components of types herein specified. Stops and traps may be as manufactured by Moen, Brasscraft, McGuire Manufacturing Company, Fluidyne Ansonia, or approved equal. Stops shall not include any PVC construction. Traps for lavatories shall not be of PVC construction, but shall be chromium plated finish, of 17 gauge minimum tubing construction. Chicago Faucet Company, T & S Brass and Bronze Works, Inc., Moen, or Cambridge Brass trim will also be acceptable, as approved by the Using Agency.
2. The Contractor shall furnish and deliver to the Using Agency, upon completion of the installations, faucet repair kits, as recommended by the successful suppliers for installations. The repair kits shall contain basic repair parts for faucets and trim herein specified.
3. All plumbing fixtures and equipment, as well as their installation, with piping, venting, and all phases of installation, must meet the minimum requirements as established by all applicable Plumbing Codes.
4. Assembly of fixtures must be made lead-free.
5. The Contractor shall be responsible for notifying the General Contractor of exact locations where plumbing equipment will be recessed. It will be necessary to coordinate the exact locations of building structural members to provide clearance for recessed plumbing equipment.
6. The Contractor's particular attention is directed to the limited wall construction thickness available for the installation of chair carriers for the various fixtures. It shall be the responsibility of this Contractor and the carrier equipment supplier to coordinate the installation of the carriers with the various wall thicknesses.
7. For fixture mounting heights, refer to Architectural Drawings. Other related fixture equipment, trim, and accessories shall be mounted or installed in accordance with roughing-in dimensions obtained from the fixture manufacturer.
8. Exposed metal trim of all plumbing fixtures, and miscellaneous equipment, shall be polished chromium-plated, except where specifically indicated otherwise. All escutcheons, floor plates, and wall plates shall be polished chromium plated cast brass, set screw type, including those escutcheons provided with equipment, such as flush valves, lavatory supplies, etc.
9. Grab bars for handicapped use at fixture locations and Toilet Room accessories will be furnished and installed by Others.

10. Upon completion of the plumbing installation, the Contractor shall adjust all new fixture flush valve control stops throughout the building for a minimum flow.
11. Exposed hot and cold water supply piping and drain piping serving ADA accessible lavatories and sinks located immediately at the fixtures shall be insulated as specified. There shall be no sharp or abrasive surfaces under handicap accessible lavatories.
12. Contractor shall furnish and install all necessary adapters required to make complete final connections.
13. Contractor shall make all necessary repairs to wall tiles, or other tiled surfaces, when damaged during installation.
14. Where exposed vertical supplies above floor are indicated for fixtures, supply piping shall be polished chromium plated, with setscrew escutcheons and 3/8-inch supplies with loose key stops.
15. The combination height of each bowl and seat for handicapped closets, floor mounted or wall hung, must meet and not exceed ADA handicapped mounting height requirements. All other handicapped fixture and trim mounting heights must also conform to ADA mounting height and clearance space requirements. The force required to operate handicapped hand-activated controls must not exceed 5 pounds. Self-closing valves shall remain open for at least 10 seconds.
16. Apply two coats of white enamel paint to all exposed cast iron parts of fixtures.

Chair Carriers

17. Wall hung lavatories shall be punched for and supported on concealed arms chair carriers, similar to the Zurn No. Z-1231, Josam, J.R. Smith, Wade, or approved equal, except as otherwise specified. Where wall hung lavatories are installed back-to-back on the same partitions, they may be furnished with double concealed arms chair carriers, similar to the Zurn No. Z-1231-D, or approved equal. Chair carriers for 20" x 18" lavatories arranged for handicapped use shall also be supported with Zurn No. Z-1231 or No. Z-1231-D carriers as required; however, carriers shall include extended height upright supports, of 42" length. All carriers as specified herein shall be specially designed for narrow partitions.
18. Urinals shall be supported on a Zurn No. Z-1221 Series chair carrier, Josam, J.R. Smith, Wade, or approved equal. Carrier shall be complete with steel uprights with support plates mounted on adjustable headers, and mounting fasteners. Carrier shall be specially designed for narrow partitions.
19. Wall hung closets shall be supported on double or single type closet supports, similar to the Zurn No. Z-1203 to No. Z-1209 Series, Josam, J.R. Smith, Wade, or approved equal, with carriers, accessories and fittings. Furnish and install for each carrier, a rear stabilizer assembly, to fasten carrier to floor construction. Closet supports shall each include a Zurn No. Z-1210-45 "Tru-Wall" or equal, finishing frame, of die-cast aluminum construction. Finishing frame shall be provided to properly align the closet in relation to the finished wall construction.

Flush Valves

20. All flush valves shall incorporate the non-hold-open feature. All flush valves shall incorporate the "low water consumption" feature and shall include vandal-proof control stop cover. Flush valves shall be as specified herein. Flush valves for handicapped fixtures shall include handicap handle assembly. For tank type fixtures, flush actuators shall be mounted on the wide side of toilet areas.

Caulking

21. Plumbing Contractor shall furnish and install caulking around wall hung fixtures, floor mounted fixtures, floor service receptors, prefabricated shower stalls, and similar fixtures. Caulking shall be the Dow Corning No. 786 Mildew Resistant Silicone Sealant, or equal, white. Coordinate all work with the General Contractor.

Flow Rates and Flush Volumes

22. The Contractor shall utilize Omni Products, or approved equal, laminar flow control, vandal-proof pressure compensating devices for lavatory and sink faucets of 1.5 gpm or greater, in lieu of the aerators normally included with the fixtures. Maximum flow rates and flush volumes for new fixtures for the project shall be as follows:

Faucets and Aerators	Refer to Plumbing Fixture Schedules on Drawings.
Water Closets	Refer to Plumbing Fixture Schedules on Drawings.
Showers	Refer to Plumbing Fixture Schedules on Drawings.
Urinals	Refer to Plumbing Fixture Schedules on Drawings.

23. Comply with applicable standards below and other requirements specified.
 - a. Electric Water Coolers: ARI 1010 and UL 399.
 - b. Enameled, Cast-Iron Fixtures: ASME A112.19.1.
 - c. National Sanitation Foundation Construction: NSF 2.
 - d. Stainless-Steel Fixtures Other than Service Sinks: ASME A112.19.3.
 - e. Vitreous-China Fixtures: ASME A112.19.2M.
 - f. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.

Lavatory/Sink Faucet Standards

24. Comply with ASME A112.18.1 and other requirements specified for lavatory, sink, and similar-type-fixture faucet fittings. Include hot- and cold-water indicators; flow rates as specified herein; and polished, chrome-plated finish; except where otherwise indicated. Coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor. Contractor to supply extra repair parts, stems, cartridges, O-rings, etc. for faucets installed.
 - a. Hose-Connection Vacuum Breakers: ASSE 1011.
 - b. Hose-Coupling Threads: ASME B1.20.7.
 - c. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 - d. Pipe Threads: ASME B1.20.1.

Miscellaneous Fitting Standards

25. Comply with ASME A112.18.1 and other requirements specified for fittings, other than faucets. Include polished, chrome-plated finish, except where otherwise indicated. Coordinate fittings with other components and connectors.

- a. Atmospheric Vacuum Breakers: ASSE 1001.
- b. Automatic Flow Restrictors: ASSE 1028.
- c. Brass and Copper, Supplies and Tubular Brass: ASME A112.18.1.
- d. Fixed Flow Restrictors: ASSE 1034.
- e. Manual-Operation Flushometers: ASSE 1037.

Miscellaneous Component Standards

- 26. Comply with applicable standards below and other requirements specified for components for plumbing fixtures, equipment, and appliances.
 - a. Hose-Coupling Threads: ASME B1.20.7.
 - b. Pipe Threads: ASME B1.20.1.
 - c. Plastic Toilet Seats: ANSI Z124.5.
 - d. Supply and Drain Insulation Kits: CABO A117.1.
 - e. Supports: ASME A112.6.1.

2.2 FIXTURES

- A. Refer to Plumbing Drawings for Plumbing Fixture Schedules. The Plumbing Fixture Schedules designates and identifies the basis of design of each fixture with detail product descriptions, make, models, components and accessories. (Typical)

2.3 WATER CLOSET COMPONENTS

- A. Water Closet W-[#]: Where plumbing fixtures of this designation are indicated, provide products complying with the following:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. American Standard America.
 - b. Kohler Co.
 - c. Zurn Industries, LLC.
 - 2. Commercial - Vitreous-China – Elongated – Wall Mounted - Standard / ADA Accessible.
 - 3. Siphon Jet – 1.28 gpf.
 - 4. Flushometer Valves.
 - 5. Fixture Colors: White.
 - 6. Toilet Seats: Solid-plastic, water-closet seat with bumpers and hardware, required for and compatible with vitreous china water closets as follows:
 - a. Color: White.
 - b. Class: Commercial, Heavy Duty, Fire retardant.
 - c. Size: Elongated.
 - d. Pattern: Open front without cover.
 - e. Hinge Type: Self-sustaining check (SC).
 - 7. Fixture Supports: Carriers, as hereinbefore indicated.

8. Fixture Supports: Where required for floor mounted fixtures, include flanges caulked tight to branch stub and set on waterproof neoprene gaskets fastened to flanges with brass bolts. Wax gasketing with neoprene boot will be acceptable.
9. Supply Inlets: 1/2-inch for flush tank water closets, 1-inch for flush valve closets, brass pipe or copper tubing, chrome plated for exposed.

2.4 URINAL COMPONENTS

- A. Urinal U-[#]: Where plumbing fixtures of this designation are indicated, provide products complying with the following:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. American Standard America.
 - b. Kohler Co.
 - c. Zurn Industries, LLC.
 2. Commercial - Vitreous China – Siphon Jet – Wall Mounted - Standard / ADA Accessible.
 3. Flushometer Valve – 0.5 gpf – 0125 gpf
 4. Supply Inlets: 3/4-inch, brass pipe or copper tubing, chrome plated for exposed.

2.5 LAVATORY COMPONENTS

- A. Lavatory L-[#]: Where plumbing fixtures of this designation are indicated, provide products complying with the following:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. American Standard America.
 - b. Kohler Co.
 - c. Zurn Industries, LLC.
 2. Commercial - Vitreous-China – 20" x 18" Wall Mounted - Standard / ADA Accessible
 3. Faucets – Lead-free polished Chrome finish.
 4. Concealed Arm Chair Carrier Support.
 5. Laminar-Flow, Faucet-Spout Fittings:
 - a. Chronomite Laboratories, Inc.
 - b. Neoperl, Inc.
 - c. Wrightway Mfg.
 6. Fitting Insulation Kits:
 - a. Brocar Products, Inc.
 - b. McGuire Manufacturing Co., Inc.
 - c. TCI Products.

d. TRUEBRO, Inc.

7. Fixture Colors: White.
8. Supply Inlets: 1/2-inch, brass pipe or copper tubing, chrome plated for exposed.
9. Supply Stops: Manufacturer's heavy duty brass, angle or straight, compression, loose-key type, same size as supply inlet and with outlet matching supply riser.
10. Supply Risers: Commercial duty, rigid.
11. Drains: Chicago Faucet Co. strainer with 1-1/2" tailpiece.
12. Tubular Traps: 1-1/2-inch, 17 gauge wall thickness, tubular brass, with slip-joint inlet, cleanout, and wall flange.
13. Supply Insulation Kits: Required for ADA accessible lavatories. Molded, soft-plastic covering for supplies from wall to fixture with removable covering for stops and handles.
14. Drain Insulation Kits: Required for ADA accessible lavatories. Molded, soft-plastic covering for drain piping from fixture to wall.
15. Fixture Supports: Refer to Chair Carriers, as herein specified.

2.6 SINK COMPONENTS

- A. Sink S-[#]: Where plumbing fixtures of this designation are indicated, and are not provided by others, provide products complying with the following:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Advanced Tabco Manufacturing.
 - b. Elkay
 - c. Just Manufacturing.
 2. Stainless Steel Sinks – Casework deck mounted single or double bowl.
 - a. Refer to Fixture Schedule for designated details.
 - b. Food Service – Kitchen – Dishwashing Area Sinks.
 - c. Bar and Lounge Sinks
 - d. Waitress Service Station – Water Station
 3. Faucet:
 - a. See Fixture Schedule.
 - b. Refer to Food Service Equipment drawings.
 4. Laminar-Flow, Faucet-Spout Fitting:
 - a. Chronomite Laboratories, Inc.
 - b. Neoperl, Inc.
 - c. Wrightway Mfg.
 5. Supply Inlets: 1/2-inch, brass pipe or copper tubing, chrome plated for exposed.
 6. Supply Stops: Heavy duty brass, angle or straight, compression, loose-key type, same size as supply inlet and with outlet matching supply riser.
 7. Supply Shutoff Valves: 1/2-inch ball.

8. Supply Risers: 3/8-inch flexible with knob end or 1/2-inch copper tubing where suitable for installation.
9. Drains: Furnish and install suitable strainer and drain line, of required sizes, with drain tubing of required length for each sink.
10. Cast-Brass Trap: Furnish and install suitable cast brass trap with slip-joint inlet and cleanout, of required size for each sink, at all locations.

2.7 SERVICE SINK BASIN COMPONENTS

- A. Service Sink Receptor Basin SS-[#]: Where plumbing fixtures of this designation are indicated, provide products complying with the following:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 2. Plastic Molded Composite Mop Service Basins:
 - a. Fiat Products, Inc.
 - b. E.L. Mustee
 - c. Zurn Industries
 3. Faucets:- Wall Mounted Service Sink 8" oc polished chrome cast brass assembly with wall brace support and hose-end pail hook spout with vacuum breaker. 1
 - a. Chicago Faucet Co
 - b. Speakman.
 - c. Zurn Industries
 4. Fixture Dimensions: As indicated on drawings.
 5. Mounting: Floor.
 6. Rim Guards: Manufacturer's standard required for exposed sides.
 7. Drains: 3-inch NPS with manufacturer's standard strainer.
 8. P-Traps: 3-inch NPS drainage piping.
 9. Supplies: 1/2-inch NPS copper tubing with ball valve.
 10. Reinforcement: Provide for wall-mounting faucet and wall brace.

2.8 SHOWER COMPONENTS

- A. Shower SH-[#]: Where plumbing fixtures of this designation are indicated, provide products complying with the following:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 2. Anti-scald Shower Faucet Control Assembly
 - a. Symmons Industries, Inc.
 - b. Zurn.
 - c. Bradley.

3. Supplies: Copper tubing with ball valve if check stops not included with faucet, at concealed locations. All exposed piping supplies and enclosure systems shall be stainless steel or polished chrome.

2.9 URINAL COMPONENTS

- A. Urinal U-[#]: Where plumbing fixtures of this designation are indicated, provide products complying with the following:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 2. Urinal:
 - a. Refer to Plumbing Fixture Schedules on the Drawings for designation, description, basis of design make, model, details and accessories.
 3. Flushometer Valve:
 - a. Refer to Plumbing Fixture Schedules on the Drawings for designation, description, basis of design make, model, details and accessories.
 4. Supply Inlets: 3/4-inch, brass pipe or copper tubing, chrome plated for exposed.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for potable, hot- and cold-water supply piping systems; soil, waste, and vent piping systems; and supports. Verify that locations and sizes of piping and locations and types of supports match those indicated, before installing and connecting fixtures. Use manufacturer's roughing-in data when roughing-in data are not indicated.
- B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.
- C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Include supports for plumbing fixtures according to the following:
 1. Chair Carriers: For wall-hanging lavatories and electric water coolers.
 2. Heavy-Duty Chair Carriers: For accessible lavatories, and other fixtures where indicated.
 3. Fabricate reinforcement from fire-retardant-treated-wood blocking between studs or steel plates attached to studs, in wall construction, to secure fixtures to wall. Include length that will extend beyond ends of fixture mounting bracket and attach to at least 2 studs.

- B. Include fitting insulation kits for accessible fixtures according to the following:
 - 1. Lavatories: Cover hot- and cold-water supplies, stops and handles, drain, trap, and waste to wall.

3.3 PLUMBING FIXTURE INSTALLATION

- A. Assemble plumbing fixtures and trim, fittings, faucets, and other components according to manufacturers' written instructions.
- B. Install fixtures level and plumb according to manufacturers' written instructions, roughing-in drawings, and referenced standards.
- C. Install wall-hanging, back-outlet water closets with support manufacturer's tiling frame or setting gage.
- D. Install toilet seats on water closets.
- E. Install wall-hanging, back-outlet urinals with gasket seals.
- F. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction where no support is indicated.
- G. Fasten floor-mounted fixtures to substrate. Fasten fixtures having holes for securing fixture to wall construction, to reinforcement built into walls.
- H. Fasten recessed, wall-mounted fittings to reinforcement built into walls.
- I. Fasten wall-mounted fittings to reinforcement built into walls.
- J. Fasten counter-mounting plumbing fixtures to casework.
- K. Secure supplies to supports or substrate within pipe space behind fixture.
- L. Install individual stop valve in each water supply to fixture. Use ball valve where specific stop valve is not specified.
- M. Install water-supply stop valves in accessible locations.
- N. Install faucet, flow-control fittings with specified flow rates and patterns in faucet spouts when faucets are not available with required rates and patterns. Include adapters when required.
- O. Install traps on fixture outlets. Omit traps on fixtures having integral traps. Omit traps on indirect wastes, except where otherwise indicated.
- P. Install escutcheons at wall, floor, and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons where required to conceal protruding pipe fittings.

- Q. Seal joints between fixtures and walls, floors, and counters using sanitary-type, 1-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
 - 1. Install piping connections between plumbing fixtures and piping systems and plumbing equipment specified in other Division 15 Sections.
- B. Supply and Waste Connections to Plumbing Fixtures: Refer to plumbing fixture schedules as herein specified for fitting sizes and connection requirements for each plumbing fixture.
- C. Supply and Waste Connections to Equipment Specified in Other Sections: Connect equipment with supply inlets, supply stops, supply risers, and traps specified in this Section. Use fitting sizes required to match connected equipment. Connect fittings to plumbing piping.
- D. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- E. Arrange for electric-power connections to fixtures and devices that require power. Electric power, 120 volt and greater, under Division 26 work.

3.5 FIELD QUALITY CONTROL

- A. Verify that installed fixtures are categories and types specified for locations where installed.
- B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized and demonstrate proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
- E. It shall be the Contractor's responsibility for testing and certification. All tests must be performed in the presence of the Using Agency or his/her representative.

3.6 ADJUSTING AND CLEANING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

- B. Adjust water pressure at electric water coolers, faucets, and flushometer valves having controls, to produce proper flow and stream.
- C. Replace washers and seals of leaking and dripping faucets and stops.
- D. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Include the following:
 - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 - 2. Remove sediment and debris from drains.

3.7 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of fixtures for temporary facilities, except when approved in writing by the Using Agency.

END OF SECTION

SECTION 224713
DRINKING FOUNTAINS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section includes drinking fountains and related components.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of drinking fountain.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include operating characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For drinking fountains to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 DRINKING FOUNTAINS

- A. Drinking Fountains: Pedestal, wheelchair accessible, freeze resistant, vandal resistant.
 - 1. Cast-Iron or Steel Drinking Fountains:
 - a. Most Dependable Fountains, Inc.
 - b. Haws.
 - c. Halsey Taylor.
 - 2. Standards:
 - a. Comply with NSF 61 and NSF 372.
 - b. Comply with ICC A117.1.

3. Pedestal: Rectangular, with bottle filler, freeze resistant, vandal resistant.
4. Receptor(s):
 - a. Material: Stainless steel.
 - b. Shape: Rectangular.
 - c. Bubbler: One for each receptor, with adjustable stream regulator.
 - d. Bottle filler: Push-button activation.
 - e. Drain: Grid type with NPS 1-1/2 tailpiece.
5. Maximum Water Flow: 0.15 gpm.
6. Controls: Push bar.
7. Access to Internal Components: Panel in pedestal.
8. Supply Piping: NPS 1/2 with shutoff valve.
9. Drain Piping: NPS 1-1/2 minimum trap and waste.
10. Freeze-Resistant Supply Fittings: Underground freeze-resistant shutoff and flow-control valve assembly.
11. Bury Depth, Grade to Valve Components: 48 inches.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls and floors for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- B. Set pedestal drinking fountains on floor.
- C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523 "Ball Valves for Plumbing Piping" and Section 220523 "Gate Valves for Plumbing Piping."
- D. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

- F. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Install ball or gate shutoff valve on water supply to each fixture. Comply with valve requirements specified in Section 220523 "Ball Valves for Plumbing Piping" and Section 220523 "Gate Valves for Plumbing Piping."
- D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.

3.5 CLEANING

- A. After installing fixtures, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.
- C. Provide protective covering for installed fixtures.
- D. Do not allow use of fixtures for temporary facilities unless approved in writing by Client Agency.

END OF SECTION

SECTION 230500

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. General Project Requirements
 - a. Definitions
 - b. General Project Coordination and Planning
 - 1) Coordination between Division 23 and Division 26
 - c. Client Agency Instruction
 - d. Delivery, Storage, and Handling
 - e. Sequencing and Scheduling
 - f. Interpretation of the Documents
 - g. Basis of Design Products and Substitutions
 - h. Submittals - General Requirements
 - i. Warranties
 - 2. Coordination Drawings
 - 3. Extra Materials
 - 4. Piping materials and installation instructions common to most piping systems
 - 5. Indoor concrete housekeeping base construction requirements
 - 6. Escutcheons
 - 7. Dielectric fittings
 - 8. Mechanical sleeve seals
 - 9. Field-fabricated metal equipment supports
 - 10. Equipment installation requirements common to equipment specification sections
 - 11. Ceiling, wall, and shaft access panels
 - 12. Control wiring
 - 13. Motor controllers and disconnect switches
 - 14. Cutting and patching
 - 15. Installation of work on the roof
 - 16. Cleaning and protection
 - 17. Painting and finishing

1.3 DEFINITIONS

- A. Atmosphere: Outside the exterior walls and roof of a building.
- B. Finished Spaces: Areas where drywall is hung or installed with wall coverings and/or painted; or where floors are polished or coverings are installed on the floor; or where the ceiling is plaster/gypsum board and/or suspended acoustic ceiling tile.
- C. Unfinished Space: Spaces other than finished spaces. Typical examples include mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, attics, crawl spaces, garages, and tunnels.
- D. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- E. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- F. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- G. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters or inside equipment enclosures.
- H. Conditioned Space: Spaces within the insulated envelope of the building and provided with both mechanical heating and air conditioning, either directly or indirectly.
 - 1. Ceiling and floor plenums and ceiling spaces (areas between the finished ceiling and the structural floor or roof slab/deck above) are considered (indirectly) conditioned spaces.
- I. Unconditioned Space: Spaces lacking either mechanical heating or air conditioning, or both, and are outside of the insulated envelope of the building. Examples: Outdoor-air-ventilated crawlspaces and attics.
 - 1. Mechanical and electrical rooms, and similar spaces, that are only heated and outdoor-air-ventilated, or are only outdoor-air-ventilated, shall be considered unconditioned spaces.
- J. Contractor: The contractor performing the work of the trade drawings or specification division where the use of the term appears, unless a more specific indication is made.
- K. Furnish: Purchase and deliver to project site, ready for unloading, unpacking, assembly, installation, and similar subsequent requirements.
- L. Install: Operations at project site required to place furnished materials and equipment into use, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, connecting, finishing, curing, protecting, cleaning, adjusting, and similar requirements.
- M. Provide: Both furnish and install.

- N. Reinstall: Remove items indicated; clean, service, and otherwise prepare them for reuse; store and protect against damage. Install items in the same locations or in locations indicated.
- O. Relocate: Same meaning as "reinstall".
- P. Remove: Remove items from their current installed condition and legally dispose of those items, except those indicated to be reinstalled/relocated or salvaged or to remain the Client Agency's property as indicated.
- Q. Demolish: Same meaning as "remove".
- R. Replace: Remove items indicated as defined under "remove" herein and provide new items with matching dimensions, capacities, and all other features in the same location as the items removed, unless explicitly indicated otherwise.
- S. Salvage (and similar terms and phrases such as "Turn Over to Client Agency"): Items indicated to be salvaged shall remain the Client Agency's property. Remove, clean, and pack or crate items to protect against damage. Identify contents of containers and deliver to Client Agency's designated storage area.
- T. Indicated: The term "indicated", "shown," "noted," "scheduled," and "specified" refers to graphic representations, notes, schedules, or other indications on the Drawings; or to other paragraphs or schedules in the Specifications and other similar requirements in the contract documents.
- U. May: Indicative of a Contractor's Option, or that which the Contractor is permitted to do, but not required to do.
- V. Shall: Indicative of a mandatory contract requirement, or that which the Contractor has a duty to perform.
- W. Must: Same meaning as "shall".
- X. Will: Unless explicitly identified as associated with the work of, or performed by, another contractor or under a separate contract, or to be future work also outside this contract, "will" shall be taken to mean the same as "shall", (i.e. representative of a mandatory requirement of this contract).
- Y. The terms "approved", "equal", "acceptable", or "proper" and words of a similar meaning shall be understood to mean "meeting the design intent as determined by the Architect or Engineer".
- Z. The terms "Engineer" and "Architect" used in these specifications are used interchangeably, and refer to the same entities - the design professionals of record.
- AA. References to "GC", "General Contractor" shall refer to the .1 Contractor.
- BB. References to "HC", "Heating Contractor", "HVAC Contractor", and "Mechanical Contractor" on the drawings depicting the HVAC system work shall refer to the .2 Contractor performing the work of Division 23.
- CC. References to "PC", "Plumbing Contractor" shall refer to the .3 Contractor performing the work of Division 22.

- DD. References to "EC" and "Electrical Contractor" on the drawings depicting the HVAC system work shall refer to the .4 Contractor performing the work of Divisions 26, 27, and 28.
- EE. Withstand, Resist: With respect to wind resistance ratings, "withstand" and "resist" shall mean to be without permanent deformation of components, fasteners and anchors, and be able to continue to function normally without water leakage or excessive vibration or air leakage, and meeting all scheduled functional performance requirements, after being subjected to the design wind speed from any direction.

1.4 ACTION SUBMITTALS (of this Section)

- A. Product Data: Provide for the following:
 - 1. Dielectric fittings
 - 2. Flexible connectors
 - 3. Fire- and smoke-stopping materials
- B. Shop Drawings: Detail fabrication and installation for metal supports and anchorage for HVAC materials and equipment.

1.5 INFORMATIONAL SUBMITTALS (of this Section)

- A. Coordination Drawings: Coordination drawings shall be prepared as specified in this Section and as defined in Division 01. Note that the requirements of this Section may be more restrictive and create additional requirements.
 - 1. Refer to the coordination article(s) elsewhere in this Section.
 - 2. No installation of permanent systems shall proceed until the coordination drawings are reviewed by the Architect / Engineer. No additional compensation shall be allowed for changes required to accommodate installation of systems provided under other Divisions of this Contract.
 - 3. Coordination drawings shall be developed from individual system shop drawings and contractor fabrication drawings. Electronic or other reproduced engineering design drawings used as coordination drawings are not acceptable.
 - 4. Coordination drawings shall be initiated by the Contractor responsible for the ductwork installation. That Contractor shall indicate, on the plans, equipment and duct locations and dimensions drawn to scale, taking into consideration and incorporating proper service and access clearances. The drawing shall then be given to the Contractors installing piping, conduit for the inclusion of their work on the coordination drawing. All discrepancies and conflicts with the architectural layout of the building shall be noted on the coordination drawings. The Contractors of the various Divisions shall meet as required to resolve discrepancies with ductwork, piping, and conduit prior and to coordinate those elements on the coordination drawings. The Contractor who initiated the coordination drawings shall submit them for review to the Architect and Engineer. Coordination and installation of work not indicated on the coordination drawing shall be the responsibility of the Contractor responsible for that equipment. Any modifications required by any Contractor for equipment to be installed that is not shown on the coordination drawing shall be the responsibility of the Contractor who failed to indicate that equipment.

- a. Coordination drawings shall be prepared for each general area, floor level, and roof level and shall be of a scale not less than 1/4 inch per 1 foot. Mechanical and electrical rooms and areas with similar levels of congestion shall be prepared at 1/2 inch per foot.
 - b. Plans and elevations shall be prepared for shafts and chases containing more than one duct or the work of multiple trades at 1/4" per foot.
 - c. Electronic Format: As required by Division 01.
5. Detail major elements, components, and systems of HVAC equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
- a. Planned ductwork layout, including all duct accessories (dampers, silencers, access doors, etc.) and control devices (airflow measuring stations, sensors, etc.).
 - b. Planned piping layout, including valve and specialty locations, meters and gauges, control devices (control valves, flow meters, sensors, etc.), and valve-stem movement.
 - c. Clearances for installing and maintaining insulation.
 - d. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
 - e. Hangers and supports for ductwork, piping, and equipment, including the size and magnitude of all point loads.
 - f. Access paths through mechanical rooms and on roofs.
 - g. Methods for maintaining required roof slope and roof drainage around rooftop installations.
 - h. Equipment and accessory service connections and support details.
 - i. Sizes and locations of access panels in ceilings, shafts, walls, etc.
 - j. Exterior wall and foundation penetrations.
 - k. Fire- and smoke-rated wall and floor penetrations. Indicate UL directory file number for the fire/smoke stopping system proposed at each penetration.
 - l. Sizes and location of required concrete pads and bases.
 - m. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
 - n. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 - o. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.
6. Access Panel Schedule: List of sizes, types, locations, and required purpose for all access panels in ceilings, shafts, walls, etc. Coordinate locations of any access panels not indicated on the Architectural Drawings with the Architect prior to installation.

1.6 CLOSEOUT INFORMATIONAL SUBMITTALS (of this Section)

- A. Electronic Files: Provide electronic files of all ductwork and piping shop drawings and interdisciplinary coordination drawings in Revit 2016 format, or later version, unless Division 01 stipulates otherwise.
 - 1. Files shall be submitted on DVDs or flash memory drives (drives will not be returned to the Contractor), unless Division 01 stipulates otherwise.

B. Operations and Maintenance Manuals: Comply with requirements in Division 01 and requirements detailed elsewhere in other Division 23 Sections. Manuals shall be provided no later than 90 days after Substantial Completion, unless an earlier date is required by Division 01. O&M manuals for Division 23 work shall also include the following:

1. Copies of manufacturer's operation and maintenance manuals for each piece of equipment provided under this Project. Required routine maintenance actions shall be clearly identified.
2. Parts and material lists, including contact information for product representative or other place to purchase.
3. List of normally replaced items, such as filters, fuses, belts, seals, gaskets, etc., indicating style, rating, size, etc., and contact information for product representative or other place to purchase.
4. Installation, servicing, maintenance, and operating instructions for all systems and components with the place of original purchase and name and contract information of the person who can service the system.
5. System and equipment startup, seasonal changeover, and seasonal shutdown with prestart checklists and precautions.
6. System and equipment troubleshooting guides.
7. Copies of manufacturers' and Contractor's guarantees and warranties.
8. Copies of approved submittals incorporating all comments and corrections noted during the final engineer review and reflecting field changes to systems and equipment:
 - a. Product data and shop drawings for all equipment.
 - b. Final, approved balancing report(s).
 - c. ATC product data and shop drawings, including component wiring diagrams, ATC wiring diagrams.
9. Schedule of all motors, starters, and controllers under this Division with the following information included:
 - a. Location
 - b. All nameplate data
 - c. Overload rating and manufacturer's number
 - d. Actual full-load amperes
 - e. Overcurrent protection
10. Spreadsheets that identify all boilers and pressure vessels that require Pennsylvania Department of Labor and Industry certificates. Include such information as identification number, type of equipment, location, PA L&I number, etc.
11. Copies of all inspection certificates and approvals from all inspection agencies.

1.7 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Factory Fabricated HVAC Equipment: Of the type, design, and size that manufacturers currently offer for sale and appears in the manufacturer's current catalogue. Equipment shall be new and fabricated from new materials, and shall be free from defects in materials and workmanship.
- D. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
- E. Minimum Energy Efficiency: Compressor-containing, fuel fired, and absorption refrigeration equipment shall meet the minimum efficiency requirements listed in the 2015 International Energy Conservation Code and ASHRAE 90.1-2013.

1.8 GENERAL PROJECT COORDINATION AND PLANNING

- A. Prior to the ordering of materials or installation of work, coordinate and pre-plan the work to the extent necessary to permit the work to be installed satisfactorily, in accordance with the Contract Documents, and with the least possible interference or delay.
- B. When work is installed without the required coordination and/or planning, changes to the work deemed necessary by the Architect shall be made to correct the conditions without additional cost to the Client Agency.
- C. The Contractor is advised to furnish complete contract documents to all suppliers, sub-contractors, and other agents. Information required by those entities for the proper completion of their work in a coordinated fashion with the work of others will typically appear in multiple places in the Contract Documents.
1. Any failure on the part of a suppliers, sub-contractors, and other agents to improperly interpret the Contractor Documents or to understand other requirements made necessary by the coordination and planning process, is the full responsibility of the Contractor.
- D. Due to the limited space available in mechanical rooms for HVAC equipment, no individual submittals for equipment in these mechanical areas will be approved in isolation. The Contractor shall submit for approval all equipment to be located in these areas in a single submittal, along with the coordination drawings of that same area and the spaces immediately below, above, and adjacent it showing piping, ductwork, conduit, roof structural framing, and any other related structural and architectural elements. Any equipment submitted in isolation or an equipment submittal package submitted which lacks the above described partial coordination drawings maybe rejected at the discretion of the Engineer and will not be reviewed until it is deemed complete.

1.9 CLIENT AGENCY INSTRUCTION

- A. Comply with the demonstration and instruction requirements indicated in other Division 23 Sections.
- B. Operations and Maintenance Manuals shall be distributed to the Client Agency no less than one (1) week prior to the instruction periods.
- C. Forward to the Architect / Engineer the signatures of all those who attended the instruction sessions.
- D. Refer to Division 01 for additional Client Agency instruction requirements.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.
- C. Protect flanges, fittings, and piping specialties from moisture and dirt.
- D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.11 SEQUENCING AND SCHEDULING

- A. Coordinate HVAC equipment and systems installation with other building components.
- B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for HVAC installations.
- C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.
- D. Sequence, coordinate, and integrate installations of HVAC materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.
- E. Coordinate requirements for access panels and doors if HVAC items such as dampers, valves and other equipment requiring access are concealed behind finished surfaces where no other means of access is available. Provide access panels and doors meeting the applicable requirements of Division 08. Coordinate locations of any access panels not indicated on the Architectural Drawings with the Architect prior to installation.

1.12 INTENT AND REQUIRED INTERPRETATION OF THE CONSTRUCTION DOCUMENTS

- A. Refer to the Article titled "Basis of Design Products and Substitutions" located elsewhere in this Section.

- B. Provide complete and functional systems for the project. The systems shall conform to the details stated in these Specifications and shown on the Drawings. Items or work not shown or specified, but required for complete systems, shall be provided and conform to accepted trade practices.
- C. The Drawings and Specifications are presented to define specific system requirements and serve to expand on the primary contract requirements of providing complete and functional systems. The drawings are diagrammatic and indicate the general arrangement and routing of the systems included in this Contractor's work.
- D. Drawings and Specifications are intended to be complementary to each other, and contract required work only may be indicated in one of these two sources. Inclusion of a scope element in either alone, or both, obligates the Contractor to provide the indicated work.
 - 1. References in specific Specification sections to other Sections or to the Drawings are made for the Contractor's convenience only, and the omission of a potential reference shall not be interpreted by the Contractor as invalidating the other (unreferenced) provisions.
- E. All work indicated in the documents shall be completed using new equipment and materials, unless explicitly indicated otherwise.
- F. The Architect / Engineer shall not be responsible for design changes or modifications except as set forth by the Architect / Engineer in writing. The Contractor shall comply with the contract documents except as directed in writing or as required by Code or manufacturer's instructions. The Contractor shall not proceed based on verbal responses by the Architect / Engineer to questions posed by the Contractor.
- G. Do not scale the Drawings. Because of the scale of the Drawings, it is not possible to indicate offsets, fittings, valves, piping and duct accessories and appurtenances, or similar items which may be required to provide complete operating systems. Carefully investigate conditions affecting the work associated with this project. Check and verify dimensions and existing conditions at the site. Install systems in such a manner that interferences between pipes, conduit, ducts, equipment, architectural and structural features are avoided. Provide items required to meet the project conditions without additional cost to the Client Agency.
 - 1. Unless there are explicit notes to the contrary on piping system flow diagrams, piping system flow diagrams are generally not intended to establish the quantity, type, and orientation of pipe elbows, tees, and caps, as the diagrams are schematic in nature and are not drawn to scale. In the event of a conflict between the graphical depictions on piping floor plans and flow diagram(s) with respect to pipe elbows, tees, and caps, the piping floor plan(s) shall take precedence.
 - 2. Many of the required piping appurtenances, valves, small or minor piping, control devices, sensors, and similar items are omitted from floor plans and sections for clarity purposes only. Refer to piping system flow diagrams, control diagrams, details, and specifications for additional required work (appurtenances) not shown on the floor plans and/or sections. The Contractor shall include in his bid price all devices shown on any one (or more) portion of the documents, as if they were shown in all locations (e.g. section, diagram, and floor plan).
- H. These documents may not explicitly disclose all final details required for a complete systems installation; however, Contractors shall possess the expertise to include the necessary appointments of complete operating systems.

- I. The Contractor shall include in his bid price the cost of all work that is an obvious, logical, or reasonably foreseeable consequence of other work explicitly indicated on the documents.
- J. Should a bidding Contractor find conflicts or discrepancies in, or omissions from, the Drawings or Specifications, or should he be in doubt as to their meaning, the bidding Contractor should at once notify the Architect, who will send written instructions to all bidders. If these are ignored by the bidding Contractor, the bidding Contractor will be responsible for furnishing the proper or workable equipment as deemed necessary by the Architect / Engineer. The same shall apply to conflicts or discrepancies between different drawings or between different specification sections.
- K. Details shown on the Drawings shall apply to all instances of such item or condition indicated elsewhere on the Drawings, with or without an explicit reference thereto.
- L. The Drawings and Specifications primarily indicate the work that is required by the contract. In selected instances, an indication of work that is NOT acceptable may be made in the contract documents in order to provide additional emphasis or clarity. The omission of a similar statement elsewhere in the Documents shall not be construed by the Contractor to mean that unspecified or unindicated work will be accepted or is permitted under this contract.
- M. Where a code or standard is referenced, unless explicitly indicated otherwise, it shall be taken to refer to the most recent published version / edition at the time of bidding.
- N. In cases where equipment and materials are specified in the singular or plural number, it is intended that such reference shall apply to as many such items as are required to complete the installation.
- O. In these Specifications, the words "shall," "shall be," "shall include," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
- P. Compliance with requirements and work described in the contract documents are the responsibility of the Contractor unless specifically stated otherwise.

1.13 BASIS OF DESIGN PRODUCTS AND SUBSTITUTIONS

- A. Basis of Design: Throughout the project specifications and drawings, materials and equipment may be indicated as the "basis of design" material or equipment. If the bidding Division 23 Contractor desires to furnish equipment of a manufacturer other than that which is indicated to be the "basis of design", even if that alternative manufacturer and/or product name are also listed, it is the full burden of the bidding Division 23 Contractor to verify, prior to submitting a bid price, that the proposed product meets all of the project requirements and specifications. The cost of any additional changes to the work, including changes to the work of other trades / Divisions, that are associated with the Division 23 Contractor's use of a product other than the "basis of design" product, shall be borne by the Division 23 Contractor at no additional cost to the Client Agency, and the proposed additional changes shall be subject to the approval of the Architect / Engineer.
- B. Listing of Product and Manufacturer Names: Where names of manufacturers of products are listed in the Specifications, the mere listing of a manufacturer's name, or of a specific product name does not relieve the Contractor of the obligation to meet all provisions of the contract documents. All proposed products, even of those of manufacturers listed in the Specifications, are subject to the requirements of the Contract, and therefore are only acceptable provided that

they meet the requirements of the Contract, as interpreted by the design professionals (Architect and Engineer).

1. Where a manufacturer or product list is preceded by "subject to compliance with requirements, provide products by one of the following:", or similar language, the Contractor shall interpret this to mean that products or manufacturers not contained within the list are not acceptable and shall not be submitted for approval without conforming to Division 01 substitution requirements.
2. Where a manufacturer or product list is preceded by "subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:", or similar language, the Contractor shall interpret this to mean that products or manufacturers other than those listed may be submitted for review and possible approval by the Architect / Engineer.

C. Specification by Product Name: Whenever an item of material or equipment is specified or described in the contract documents by using the name of a proprietary item or the name of a particular supplier, without the listing of additional product or supplier name(s), the Contractor shall interpret the documents to mean that no other product or supplier may be used. However, where the phrase "or-equal" follows the product or supplier name, the name reference is intended to establish the type, function, appearance, and quality required. Other items of material or equipment or material or equipment of other suppliers may be submitted to Architect / Engineer for review under the circumstances described below.

1. "Or-Equal" Items: If, in the Architect / Engineer's sole discretion, an item of material or equipment proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related work will be required, it may be considered by Engineer as an "or-equal" item. For the purposes of this Paragraph, a proposed item of material or equipment will be considered functionally equal to an item so named if:

a. In the exercise of reasonable judgment the Architect / Engineer determines that:

- 1) It is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;
- 2) It will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole; and
- 3) It has a proven record of performance and availability of responsive service.

b. Contractor certifies that, if approved and incorporated into the work:

- 1) There will be no increase in cost to the Client Agency or increase in contract times; and
- 2) It will conform substantially to the detailed requirements of the item named in the contract documents.

D. Product Availability:

1. Where a product name or model number is indicated on the drawings or specifications and that product model is no longer available, the bid price shall include the currently available product model with the equal or greater quality, capacity, features, and warranty as the unavailable model listed.

2. The Contractor is responsible for confirming that all specified products will be available in a timely manner to meet the contract schedule. Should the delivery time schedule of any specified product be an issue that could adversely affect the project schedule, the Contractor shall notify the Architect, in writing, within 14 days following the award of the contract. Documentation as to when specified products were ordered and anticipated delivery dates will be required to be submitted to the Architect at this time.

1.14 SUBMITTALS - GENERAL REQUIREMENTS

- A. Refer to Division 01 for basic requirements.
- B. The Contractor shall provide product data and shop drawings for all equipment, systems, products, and materials proposed for installation under this contract, and as directed in other Division 23 Sections and Division 01.
- C. All product data submittals shall be accompanied by separate and dedicated list of proposed deviations from the requirements of the contract documents. Submittals lacking this list may be rejected solely on these grounds.
- D. Provide manufacturer's performance curves showing all available performance characteristics with submittals for all fans and pumps utilized on the project.

1.15 WARRANTIES

- A. Defective equipment, materials or workmanship, including damage to the work provided under other Divisions of this contract, shall be replaced or repaired at no additional cost to the Client Agency for the duration of the stipulated guarantee periods.
- B. General Project Warranty: Refer to Divisions 00 and 01.
- C. Special Warranties: Special manufacturers' warranties that extend beyond the general warranty period are specified in other Division 23 Sections. Special warranties shall not deprive Client Agency of other rights Client Agency may have under other provisions of the contract documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the contract documents.
 1. Where the duration of a manufacturer's standard warranty exceeds that specified for the special warranty, the manufacturer's warranty shall take precedence.
 2. Where the duration of a manufacturer's standard warranty is less than that specified, the manufacturer shall provide a special warranty extension as required, and shall provide a certificate attesting to that extension with the equipment submittal. Failure to include that certificate with the submittal shall be grounds for rejection of the submittal.
 3. Special warranties shall defined be interpreted to be non-pro-rated, unless noted otherwise, and shall begin on the date of Substantial Completion.
 4. Special warranties and their obligations to the Client Agency which have been violated by the Contractor's actions (e.g. method of handling, installation, storage, operation, etc.) shall become the responsibility of the Contractor for the original factory warranty duration and coverage. In such cases, the Contractor shall issue written documentation to the Client Agency attesting to the Contractor's acknowledgement of this responsibility.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional::
1. Transition Pipe Fittings (Metal to Plastic):
 - a. Eslon Thermoplastics.
 - b. Thompson Plastics, Inc.
 - c. NIBCO, Inc.; Chemtrol Div.
 2. Dielectric Flanges:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Co.
 - c. Epco Sales Inc.
 - d. Watts Industries, Inc.; Water Products Div.
 - e. Zurn Industries, LLC
 3. Dielectric Nipples:
 - a. Grinnell Mechanical Products
 - b. Perfection Corp.
 - c. Victaulic Co.
 4. Mechanical Sleeve Seals:
 - a. Advance Products and Systems Inc.
 - b. Calpico, Inc.
 - c. Flexicraft Industries
 - d. Metraflex Co.
 - e. GPT, an EnPro Industries Company
 - f. Proco Products Inc.
 5. Motor Controllers and Disconnect Switches:
 - a. ABB
 - b. Allen-Bradley
 - c. Eaton
 - d. Schneider-Electric
 - e. Siemens

2.2 PIPE AND PIPE FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Solder Filler Metals: ASTM B 32.
 - 1. Alloy Sb5: 95 percent tin and 5 percent antimony, with 0.20 percent maximum lead content.
 - 2. Flux: ASTM B 813, non-self-cleaning type.
- C. Brazing Filler Metals: AWS A5.8.
 - 1. Use Type BCuP (copper-phosphorus) alloy meeting AWS 'BCuP-3' specification (e.g. Sil-Fos 5, or approved equal) for joining copper socket fittings with copper pipe.
 - 2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.
- D. Solvent Cements: Manufacturer's standard solvent cements for the following:
 - 1. CPVC Piping: ASTM F 493.
 - 2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.4 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
- B. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

2.5 DIELECTRIC FITTINGS

- A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.
- B. Description: Combination of copper alloy and ferrous steel; threaded, solder, plain, and weld-neck end types and matching piping system materials.
- C. Insulating Material: Suitable for system fluid, pressure, and temperature.
- D. Dielectric Nipples: IAPMO PS 66. Electroplated steel nipple complying with ASTM F 1545 with inert and noncorrosive, thermoplastic lining; plain, threaded ends; and 150-psig (1035- or 2070-kPa) minimum working pressure at 225 deg F.
- E. Dielectric unions are strictly prohibited. Use dielectric nipples on threaded connections.

2.6 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve. Concentric or eccentric types to suit field conditions.
 - 1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Stainless steel. Include two for each sealing element.
 - 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each link.
 - 4. Pressure Rating: Designed for up to 20 psig differential, with a 4x safety factor.

2.7 PIPING SPECIALTIES

- A. Sleeves: The following materials are for wall, floor, slab, and roof penetrations:
 - 1. Steel Sheet Metal: 0.0336-inch minimum thickness (22 gauge), galvanized, round tube closed with welded longitudinal joint.
 - 2. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends.
 - 3. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
 - 4. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - a. Underdeck Clamp: Clamping ring with set screws.
- B. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type if required to conceal protruding fittings and sleeves.
 - 1. ID: Closely fit around pipe, tube, and insulation of insulated piping.
 - 2. OD: Completely cover opening.
 - 3. Cast Brass: One piece, with set screw. Polished chrome-plated finish.-
 - 4. Cast Brass: Split casting, with concealed hinge and set screw. Polished chrome-plated finish.
 - 5. Stamped Steel: One piece, with set screw and chrome-plated finish.
 - 6. Stamped Steel: One piece, with spring clips and chrome-plated finish.
 - 7. Stamped Steel: Split plate, with concealed hinge, set screw, and chrome-plated finish.
 - 8. Stamped Steel: Split plate, with concealed hinge, spring clips, and chrome-plated finish.
 - 9. Cast-Iron Floor Plate: One-piece casting.

2.8 MOTOR CONTROLLERS AND DISCONNECT SWITCHES

- A. Throughout this specification, where mechanical equipment is specified to be factory furnished with disconnect switches and/or motor starters, the equipment provided shall be furnished with combination full voltage magnetic starters and fused disconnect switches. All starters and disconnect switches provided under Division 23 shall conform to applicable Division 26 specifications.
- B. Where factory-mounted disconnect switches or motor controllers (magnetic starters or VFDs) are specified in Division 23 Sections, and the equipment manufacturer does not offer such a switch or motor controller as factory equipment, a loose switch or motor controller shall be furnished by

the Division 23 Contractor to the Division 26 Contractor for field installation. Switch and motor controller installation and additional wiring costs shall be borne by the Division 23 Contractor.

- C. The short circuit rating of starters, switches, and equipment mounted power distribution and control panels shall be no less than 10,000 AIC, or as elsewhere specified in Division 23 or 26, whichever value is highest.
- D. Starters shall have three (3) current overload relays and low-voltage release. Starters shall be furnished with "Hand-Off-Automatic" switch, red-run light, overload reset, a full set of extra interlocks with provisions for additional sets and a control transformer of ample capacity with 120 volt fused control circuit.
- E. Enclosures shall be NEMA 1 or 12 indoors, and NEMA 3R or 4X where outdoors / exposed to weather.
- F. Where single phase motors are designated to be factory furnished with disconnect switches, the motor shall incorporate a NEMA KS 1, Type HD disconnect switch, with lockable handle.
- G. Disconnect switches shall be horsepower rated to match the horsepower of the motors plus 1.15 service factors.

2.9 CEILING, WALL, AND SHAFT ACCESS PANELS

- A. The Division 23 Contractor shall provide factory-fabricated access panels for access to concealed dampers, valves and other equipment provided under Division 23 where no other means of access is available. Unless more restrictive requirements are referenced in Division 08, comply with the following:
 - 1. Access panels shall be of appropriate size but not less than 20x20 inches, flush type, hinged to drop down and out, screwdriver-operated, stainless steel in tile work and prime coated sheet steel in drywall, plaster or acoustical tile. Exact locations and sizes of panels shall be determined by the Contractor, but panels shall be located for a symmetrical appearance. Locations for access panels in finished areas must be approved by the Architect / Engineer. Access panels are not required at lift-out removable tile ceilings.
- B. Acceptable manufacturers / products are specified in Division 08.

PART 3 - EXECUTION

3.1 CUTTING AND PATCHING

- A. The Division 23 Contractor shall include in his bid all cutting and patching work required for the installation of HVAC work performed under Division 23. Any damage incident to cutting or other causes in the performance of the contract work shall be made good by replacement or repairs in a manner satisfactory to the Architect/ Engineer.
- B. Where piping, ducts, or other equipment pass through fire or smoke rated construction, furnish and install sleeves and thoroughly seal openings around sleeves, pipes, ducts, etc. With fire and

smoke resistant materials. Materials shall be provided to maintain the fire rating of the adjacent construction in accordance with the requirements of NFPA and other applicable codes.

- C. No structural members shall be cut without prior approval of the Architect.
- D. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.
- E. Repair cut surfaces to match adjacent surfaces.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. General: Install piping as described below, unless piping Sections specify otherwise. Individual Division 23 piping Sections specify unique piping installation requirements.
- B. General Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Due to the small scale of the Drawings, it is not practical to indicate offsets, fittings, valves or similar items, to make a complete operating system. The Drawings are generally diagrammatic and indicative of the work to be installed. The Contractor shall carefully investigate conditions affecting his work and shall install his work in such a manner that interference between pipes, conduit, ducts, equipment, architectural and structural features will be avoided and shall furnish and install such offsets or fittings to meet the conditions at the building, so as to avoid interference without additional cost to the Client Agency.
- C. Supporting suspended piping and associated components from the underside of the roof and floor decking in steel framed buildings is prohibited. All suspended piping and associated components shall be supported from the building steel structural system.
- D. Install piping at indicated or required slope.
- E. Install components with pressure rating equal to or greater than system operating pressure.
- F. Install piping in concealed locations, except in equipment rooms and service areas, or where explicitly indicated otherwise on the Drawings.
- G. Install piping free of sags and bends.
- H. Install exposed and concealed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.
- I. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.
- J. Install piping to allow application of insulation plus 1-inch clearance around insulation.
- K. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
- L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

- M. Elbows: Install factory-fabricated elbows for changes in direction. Long radius elbows shall be used, and changes in elevation shall be performed with two (2) 22.5 deg. elbows in lieu of 45 or 90 degree elbows.
- N. Tee Fittings and Branch Connections: Install branch connections to mains using factory-fabricated tee fittings in main with takeoff out bottom of main, except for up-feed risers with takeoff out top of main line or where space constraints do not permit.
1. "T-drill and similar piping system tee forming techniques are not permitted. Use tee fittings.
 2. Converging and diverging "bull-head" tees will not be permitted in piping systems; only branch-tee connections are permitted.
- O. Install couplings according to manufacturer's written instructions.
- P. Piping Escutcheons: Provide for pipe penetrations of walls, floors, and ceilings. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
1. Select escutcheon types according to the following:
 - a. Uninsulated Piping: Cast brass or stamped steel, with set screw or spring clips, and chrome-plated finish.. Hinged type for existing piping; one-piece for new piping.
 - b. Floor Penetrations in Utility / Equipment Room Areas: Cast-iron floor plates. One piece for new piping; split-casting type for existing piping.
 - c. Insulated Piping: Cast brass or stamped steel; with concealed hinge, spring clips, and chrome-plated finish.
- Q. Interior Piping Penetrations: Provide sleeves for pipes passing through interior concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 2. Build sleeves into new walls and slabs as work progresses.
 3. Provide sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than 6-inch NPS.
 - b. Steel, Sheet-Metal Sleeves: For pipes 6-inch NPS and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 - 1) Seal space outside of sleeve fittings with nonshrink, nonmetallic grout.

4. Seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants. Use Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant, unless otherwise indicated.
- R. Mechanical Sleeve Seal System Selection: Follow the manufacturer's selection and installation instructions. Select type, size, and number of sealing elements required for piping temperatures, material, and size, and for sleeve ID or hole size. Position piping in center of sleeve or core drilled penetration, without eccentricity or axial misalignment. Assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal. Follow manufacturer's instructions for tightening bolts. The use of split-type wall mounted sealing sleeves and eccentric type sleeve seals to adjust for misalignment conditions will only be permitted with the explicit approval of the Architect / Engineer.
- S. Verify final equipment locations for roughing-in.
- T. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.

4. PVC Nonpressure Piping: Join according to ASTM D 2855.

3.4 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 1. Install unions, in piping NPS 2 and smaller, adjacent to each control valve and at final connection to each piece of equipment.
 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and other flanged pipeline appurtenances, and at final connection to each piece of equipment.

3.5 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in wet, or intermittently wet, piping systems at connections between dissimilar metallic materials in the system. Exceptions are as follows:
 1. Where bronze or stainless steel bodied valves are connected to a black steel piping system.
 2. Where the dissimilar metallic materials at the connection are within the same material group, as defined below:
 - a. Nickel Group: Nickel, and nickel alloys with greater than 20% nickel (e.g. Monel, Hastelloy, etc.).
 - b. Stainless Steel Group: Series 300 (e.g. 304, 316, 316L, 317, etc.) austenitic stainless steels, and type 18-8 stainless steel.
 - c. Ferrous Group: Black steel, wrought iron, cast iron, and cast steel.
 - d. Copper Group: Copper, brass, aluminum bronze, silicon bronze, 90-10 copper-nickel, and 80-20 copper-nickel.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples. Dielectric unions are prohibited.

3.6 EQUIPMENT AND PRODUCT INSTALLATION - COMMON REQUIREMENTS

- A. Install manufactured equipment, products, and systems in full accordance with the manufacturer's requirements and recommendations. Note that the manufacturer's requirements and recommendations may be more restrictive or require work beyond that explicitly shown on the contract documents. If a manufacturer permits but does not explicitly require their product to be installed in a manner that is inconsistent or incompatible with the contract documents, the content of the contract documents shall take precedence.
- B. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.
- C. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.
- D. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

- E. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- F. Install equipment giving right of way to piping installed at required slope.
- G. Supporting equipment from roof and floor decking in steel framed buildings is prohibited. All equipment shall be supported from building steel structural system.

3.7 CONTROL WIRING

- A. Power wiring will be provided under Division 26. Unless otherwise indicated on the drawings, 120 volt control and interlock wiring for HVAC systems and equipment will also be provided under Division 26. Low voltage (24 volt) control wiring for HVAC systems and equipment shall be provided under Division 23. Coordinate all work between Divisions.
- B. Control wiring shall be in accordance with the National Electrical Code and Division 26 of these specifications and shall not be in conflict with state and local codes. All control wiring, including low voltage wiring, outside of control panels shall be run in rigid conduit or EMT, and installed in strict accordance with the requirements of NEC. Wiring for controls, except the low voltage conductors, shall be single conductor solid or stranded copper not less than No. 12 AWG, 90 degrees C., with 600-volt Type THHN/THWN insulation. Wiring in panel construction may be No. 16 or No. 18 AWG copper provided same is properly protected and/or is in accordance with the NEC. No temperature control wiring installed under this contract shall be installed in the building lighting and power circuit system.
- C. Low voltage two conductor and three conductor wire shall be twisted (six turns per foot) 16 AWG or 18 AWG wire, 1/32, 90 degrees C., 600 volt THHN/THWN insulation. Cable shall be as manufactured by Alpha Wire Company, Belden Wire Company, Standard Wire and Cable or approved equal.
- D. All conduit, fittings, hangers and accessories for control wiring installed under Division 23 shall conform to the levels of quality specified under Division 26.

3.8 CLEANING AND PROTECTION

- A. Cleaning: General cleaning requirements are specified in Division 01. Upon completion of the work, clean the exterior surface of equipment, accessories, and trim installed.
- B. The Division 23 Contractor shall clean up areas as the work progresses and remove waste and debris produced by performance of the Division 23 work daily or when directed by the Client Agency or Architect / Engineer.
- C. Protection of Surfaces:
 - 1. Protect new and existing surfaces from damage during the construction period.
 - 2. Provide plywood or similar material under equipment or materials stored on floors or roofs. Provide protection in areas where construction may damage surfaces.

3. Surfaces damaged during the construction shall be repaired or replaced at the cost of the Contractor at fault. The method of repairing or replacing the surface shall be approved by the Client Agency and Architect/Engineer.

D. Protection of Equipment and Materials:

1. Equipment and materials shall be stored in a manner that shall maintain an orderly, clean appearance. If stored on-site in open or unprotected areas, equipment and material shall be kept off the ground and out of standing water by means of pallets or racks, and covered with tarpaulins.
2. Equipment and material, if left unprotected and damaged or soiled, shall be repainted, repaired, or otherwise refurbished at the discretion of the Architect and Client Agency. Equipment and material is subject to rejection by the Architect, if, in the opinion of the Architect or the manufacturer's engineering department, the equipment has deteriorated or been damaged to the extent that its utility, performance, or life expectancy has been reduced. Rejected materials shall be replaced.
3. During the construction period, protect ductwork, piping and equipment from damage and dirt. Properly cap ductwork and piping. Each system of piping shall be flushed to remove grit, dirt, sand, and other foreign matter for as long a time as required to thoroughly clean the systems.

3.9 TEMPORARY / CONSTRUCTION-PHASE HVAC SERVICES

- A. Do NOT utilize the permanent HVAC systems, or any portion thereof, to provide construction-phase heating, cooling, ventilation, exhaust, or dehumidification required by the construction process until the permanent systems are permitted to operate continuously, and outside of the start-up process. Temporary systems shall be provided to meet all HVAC needs prior to that time. Temporary / construction-phase HVAC shall be provided by the General Contractor, unless Division 01 indicates otherwise.
- B. Refer to Division 23 Section "Ductwork" for requirements related to HVAC system and equipment start-up.

3.10 PAINTING AND FINISHING

- A. Painting of HVAC systems, equipment, and components is specified in Division 09. In the event of a direct conflict between the provisions of Division 09, and this Section, Division 09 shall take precedence.
- B. Do not paint piping specialties and similar items with factory-applied finish. Do not paint bronze or copper materials. Do not paint fastener threads (except on pipe hangers and threaded rods), nameplates, identification devices and labels, flexible connectors, vibration control devices, and meters and gauges.
 1. Apply protection to items not receiving paint prior to paint surface preparation and painting.
- C. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

- D. At locations where it is necessary to cut and patch existing construction to perform Division 23 work, painting at each location shall be performed by the Division 23 Contractor. New finishes shall match existing finishes. Comply with the provisions of Division 09.

3.11 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Refer to Division 05 for metal fabrications.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- C. Furnish and install miscellaneous iron work including, but not limited to, piping hangers, piping anchors and guides, ductwork hangers and supports, and HVAC equipment supports. Additional structural members shall be furnished and installed to support the HVAC equipment without excessive stress or strain on the building construction. Structural beams and other structural members shall be furnished and installed under this Division for anchors and guides where the building steel is not available or of sufficient size or weight to support or anchor pipe lines and equipment.
- D. Equipment and materials furnished and installed under this Division which are not mounted on bases or floors shall be securely attached and supported from the main supporting structure of the building by metal hangers, clamps and/or brackets. Metal hangers, clamps and/or brackets shall be of suitable design and of sufficient strength to properly and safely support the materials and equipment involved.
- E. Field Welding: Comply with AWS D1.1.
 - 1. Welding shall be done by qualified welders certified as having fully complied with acceptable qualification tests as prescribed by a reputable testing agency using procedures approved by the American Welding Society.
- F. Structural steel members installed at the exterior of the building or in damp or wet locations shall be hot dipped galvanized after fabrication. Conform to ASTM A123. Where exterior structural steel members are cut, drilled or welded, or galvanizing is damaged, repair with a cold galvanizing repair compound with dry film containing not less than 93 percent zinc dust by weight, and complying with DOD-P-21035A or SSPC-Paint 20, as manufactured by ZRC Products Company, or equivalent.

END OF SECTION

SECTION 230513

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on AC power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
- B. Related Sections include the following:
 - 1. Division 23 Sections for application of motors and reference to specific motor requirements for motor-driven equipment.

1.3 INFORMATIONAL SUBMITTALS

- A. Variable Frequency Drive (VFD) Testing and Adjustment Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Listing and Labeling: Provide motors specified in this Section that are listed and labeled.
 - 1. Terms "Listed and Labeled": As defined in the National Electrical Code, Article 100.
- C. Minimum Efficiency: Conform to requirements of NEMA MG 1, Table 12-12, as per the Federal Energy Independence and Security Act of 2007 (EISA), and DOE 10 CFR 431, as applicable, for minimum energy efficiency ratings of motors.
- D. Source Quality Control: Perform the following routine tests according to NEMA MG 1:
 - 1. Measurement of winding resistance.
 - 2. No-load readings of current and speed at rated voltage and frequency.
 - 3. Locked rotor current at rated frequency.

4. High-potential test.
5. Alignment.

1.5 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 1. Motor controllers.
 2. Torque, speed, and horsepower requirements of the load.
 3. Ratings and characteristics of supply circuit and required control sequence.
 4. Ambient and environmental conditions of installation location.
- B. The Division 23 HVAC installer shall be responsible for any additional costs to the Division 26 electrical installer such as VFDs resulting from providing motors with high inrush current ratings such as "super premium" AC induction motors with design A starting characteristics, and any changes in motor sizes initiated by the Division 23 HVAC installer, from sizes scheduled on the Drawings.
- C. Coordinate with the variable frequency drive suppliers to perform drive settings and adjustments appropriate for each drive and control application.

1.6 SPECIAL WARRANTY

- A. Manufacturer's Extended Warranty on Motors Used with Variable-Frequency Controllers: Written warranty, signed by manufacturer agreeing to repair or replace motor, including labor.
 1. Warranty Period: Manufacturer's standard, but not less than three (3) years after date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 1. Lincoln Motors; Div. of Regal Beloit
 2. Marathon Motors; Div. of Regal Beloit
 3. General Electric Co.
 4. Toshiba
 5. Baldor / Reliance Electric Co.
 6. US Motors; Div. of Nidec Motor Corp.
 7. WEG Electric Corp.
 8. Siemens
 9. TECO-Westinghouse Motor Co.
 10. Leroy-Somer; Div of Emerson Industrial Automation

2.2 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. Frequency Rating: 60 Hz.
- D. Voltage Rating: Determined by voltage of circuit to which motor is connected.
- E. Service Factor: According to NEMA MG 1, unless otherwise indicated.
- F. Enclosures: Open drip-proof (ODP), unless otherwise indicated. Use totally enclosed fan-cooled (TEFC) motors where installed at the exterior of the building or where installed in damp or wet locations.
- G. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.
- H. Overload Protection:
 - 1. All motors shall be provided with thermal overload protection at the manual or magnetic motor starter or variable frequency controller, as per NFPA 70.
 - 2. All single phase motors, and all three phase motors used with variable frequency controllers shall have integral thermal protective devices.

2.3 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.4 POLYPHASE MOTORS

- A. Description: NEMA MG 1, medium induction motor.
 - 1. Design Characteristics: NEMA MG 1, Design B, unless otherwise indicated.
 - 2. Minimum Energy-Efficient Design: Conform to EISA requirements.
 - 3. Stator: Copper windings, unless otherwise indicated. Multispeed motors have separate winding for each speed.
 - 4. Rotor: Squirrel cage, unless otherwise indicated.
 - 5. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
 - 6. Temperature Rise: Match insulation rating, unless otherwise indicated.
 - 7. Insulation: Class F, unless otherwise specified.

8. All squirrel cage, three phase, induction motors 15 HP and larger shall have a maximum locked rotor starting KVA/HP no greater than that specified for NEMA Code "G" (5.6 to 6.3).

2.5 SINGLE-PHASE MOTORS

- A. Type: As indicated or selected by manufacturer from one of the following, to suit starting torque and other requirements of specific motor application.
 1. Permanent-split capacitor.
 2. Split-phase start, capacitor run.
 3. Capacitor start, capacitor run.
 4. Electrically commutated.
- B. Shaded-Pole Motors: Do not use.
- C. Electrically Commutated (EC) Motors (ECMs): Synchronous, constant torque, brushless DC design with a permanent magnet rotor and solid state inverter circuitry to accept and AC power input and to control the power output and speed of rotation. Provide ECMs where explicitly indicated, either in other Division 23 Sections, or on the Drawings, with the following characteristics:
 1. Integral controllability down to 20% of full, rated speed. No external speed controller shall be required.
 2. Speed shall be adjustable by integral potentiometer dial (for balancing purposes) and/or by external 0-10 VDC control signal, as required by the application and control sequence of operation. Motors serving fans and pumps indicated in the sequence of operation to have on-off and/or speed control shall receive an external binary and/or analog signal for this purpose. Note that for many EC motors, a zero (0) -VDC or -mA analog speed control signal is used to automatically de-energize the motor. Coordinate signal type requirements with the control system sub-contractor / supplier performing the work of Division 23 Section "Instrumentation and Control for HVAC". For bidding purposes, provide EC motors with both a manual dial and the ability to receive an analog speed signal.
 3. Minimum 75% efficiency over full speed range.
 4. Ball bearings which are not dependent on motor speed for lubrication.
 5. Integrated power factor correction filter.
 6. Integrated motor protection verified by UL to protect the pump against over-/undervoltage, overtemperature of motor and/or electronics, overcurrent, locked rotor, and dry run (no-load condition).
- D. Thermal Protection: Internal protection automatically opens power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal protection device automatically resets when motor temperature returns to normal range.
- E. Bearings: Ball-bearing type for all EC type motors, belt-connected motors, and other motors with high radial forces on motor shaft. Sealed, permanently prelubricated sleeve bearings are acceptable for other, single-phase motors.

PART 3 - EXECUTION

Not Applicable

END OF SECTION

SECTION 230519

METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes meters and gages and related accessories for HVAC piping systems.
- B. Related Sections include the following:
 - 1. HVAC equipment Sections that specify meters and gages as part of factory-fabricated equipment.

1.3 ACTION SUBMITTALS

- A. Product Data: Include scale range, ratings, and calibrated performance curves for each meter, gage, fitting, specialty, and accessory specified. Include schedule indicating manufacturer's number, scale range, fittings, and location for each meter and gage.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For meters and gages to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1. Liquid-in-Glass Thermometers:
 - a. Weksler / Ashcroft Inc.
 - b. Ernst Flow Industries
 - c. Miljoco Corp.
 - d. Terrice: H. O. Terrice Co.

- e. Weiss Instruments, Inc.
2. Pressure Gages:
 - a. Weksler / Ashcroft Inc.
 - b. Ernst Flow Industries
 - c. Miljoco Corp.
 - d. Trerice: H. O. Trerice Co.
 - e. Weiss Instruments, Inc.
 3. Test Plugs (P/T Ports):
 - a. Flow Design, Inc.
 - b. MG Piping Products Co.
 - c. National Meter.
 - d. Peterson Equipment Co., Inc.
 - e. Sisco Manufacturing Co.
 - f. Trerice: H. O. Trerice Co.
 - g. Watts Industries, Inc.; Water Products Div.
 4. Sight Flow Indicators:
 - a. Axiom Industries
 - b. Dwyer Instruments Inc.
 - c. Emerson Process Management; Rosemount Div.
 - d. Ernst Flow Industries
 - e. Kobold Instruments Inc.
 5. Make Up Water Meters:
 - a. Master Meter, Inc.
 - b. Hersey; a Div. of Mueller Systems LLC
 - c. Sensus Technologies, Inc.
 - d. Badger Meter Inc.
 - e. Neptune Technology Group

2.2 LIQUID-IN-GLASS THERMOMETERS

- A. Scale Range: Temperature ranges for services listed are as follows:
 1. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions.
- B. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.
- C. Description: ASTM E 1.
- D. Case: Die cast and aluminum finished in baked-epoxy enamel, glass front, spring secured, 9 inches long.

- E. Adjustable Joint: Finish matching case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.
- F. Tube: Red or blue reading, inorganic liquid-filled with magnifying lens.
- G. Scale: Satin-faced non-reflective aluminum with permanently etched markings.
- H. Stem: Copper-plated steel, aluminum, or brass for separable socket; of length to suit installation.

2.3 SEPARABLE SOCKETS (THERMOWELLS)

- A. Description: Fitting with protective socket for installation in threaded pipe fitting to hold fixed thermometer stem. Sockets shall be a 1-piece machined design. Two-piece welded types are not acceptable.
 - 1. Standard: ASME B40.200.
 - 2. Material:
 - a. Brass, for use in copper piping.
 - b. Type 304 or 316 stainless steel, for use in steel piping.
 - 3. Extension-Neck Length: Nominal thickness of 2 inches, but not less than thickness of insulation. Omit extension neck for sockets for piping not insulated.
 - 4. Insertion Length: To extend 2 inches into pipe.
 - a. For piping smaller than 3-inches, provide a tee fitting and bushing for the installation of the thermowells. Position the bushing and thermowell on the top of the pipe.
 - 5. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
 - 6. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
 - 7. Bore: Diameter required to match thermometer bulb or stem.
 - 8. Cap: Threaded, with chain permanently fastened to socket.
 - 9. Bushings: For converting size of socket's internal screw thread to size of thermometer connection.
- B. Heat-Transfer Compound: Thermally conductive compound (grease or paste form), containing heat conducting additives, suitable for service temperatures up to 390 deg F.
 - 1. Minimum conductivity (k): 16 BTU-in / hr-sq.ft-deg. F.
 - 2. Acceptable product: Omega Instruments "Omegatherm 201", or approved equal.

2.4 PRESSURE GAGES

- A. Description: Designed to measure the pressure of a single pressure source. ASME B40.1, phosphor-bronze bourdon-tube type with bottom connection; dry type, unless liquid-filled-case type is indicated. Liquid filled types should be filled with low temperature glycerin.

- B. Case: Drawn steel, brass, or aluminum with 4-1/2-inch-diameter, glass lens.
 - 1. Exception: Gauges located over 7 feet above the finished floor shall be 6-in. diameter, and shall be positioned so that they are readable from floor level.
- C. Connector: Brass, NPS 1/4.
- D. Flexible Capillary Tube: For use with remote mounted gauge on installations where the gauge is subject to pipeline vibration, such as immediately adjacent to pumps.
- E. Scale: White-coated aluminum with permanently etched markings.
- F. Accuracy: Grade A, plus or minus 1 percent of middle 50 percent of scale.
- G. Range: Comply with the following:
 - 1. Fluids under Pressure: Two times the operating pressure.
 - 2. Vacuum: 30 inches Hg of vacuum to two times the operating pressure.

2.5 DIFFERENTIAL PRESSURE GAUGES

- A. Description: Designed to measure the differential pressure between two separate pressure sources. Bourdon tube, dry type, with brass or stainless steel body and case. Case shall be minimum 4-1/2" diameter. Pressure and temperature rating of no less than 1,000 psig and 200 deg. F. Provide an isolation valve and snubber on each connection to the gauge.
- B. Connector: Brass or stainless steel, NPS 1/4.
- C. Flexible Capillary Tube: For use with remote mounted gauge on installations where the gauge is subject to pipeline vibration, such as immediately adjacent to pumps.
- D. Scale: White with black markings, and glass window.
- E. Accuracy: Plus or minus 2 percent of full scale.
- F. Range: Available in 0-5 psid, 0-10 psid, 0-15 psid, 0-30 psid, and 0-60 psid ranges. Select range appropriate for application.

2.6 PRESSURE-GAGE FITTINGS

- A. Valves: NPS 1/4 brass or stainless-steel needle type.
- B. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure. Include extension for use on insulated piping.
- C. Syphons: NPS 1/4 coil of brass tubing with threaded ends.

2.7 TEST PLUGS (P/T PORTS)

- A. Description: Nickel-plated, brass-body test plug in NPS 1/2 fitting.
- B. Body: Length as required to extend beyond insulation.
- C. Pressure Rating: 500 psig minimum.
- D. Core Inserts: Two self-sealing valves, suitable for inserting 1/8-inch OD probe from dial-type thermometer or pressure gage.
- E. Core Material for Air, Water, Oil, and Gas: 20 to 200 deg F, chlorosulfonated polyethylene synthetic rubber.
- F. Test-Plug Cap: Gasketed and threaded cap, with retention chain or strap.
- G. Gauge Kit: Furnish one (1) gauge kit to the Client Agency. The kit shall include a pressure gage and adapter with probe, two bimetal dial thermometers, and padded carrying case.
 - 1. Pressure Gage and Thermometer Ranges: Approximately two (2) times the system's operating conditions.

2.8 SIGHT FLOW INDICATORS

- A. Description: Piping inline-installation device for visual verification of flow. Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends. Size shall match connecting piping.
 - 1. Minimum Pressure Rating: 125 psig.
 - 2. Minimum Temperature Rating: 200 deg F.
 - 3. End Connections for NPS 2 and Smaller: Threaded.
 - 4. End Connections for NPS 2-1/2 and Larger: Flanged.

PART 3 - EXECUTION

3.1 METER AND GAGE INSTALLATION, GENERAL

- A. Install meters, gages, and accessories according to manufacturer's written instructions for applications where used.

3.2 THERMOMETER INSTALLATION

- A. Install thermometers and adjust vertical and tilted positions.
- B. Install separable sockets (thermowells) in vertical position in piping tees where fixed thermometers are indicated.
 - 1. Install with socket extending a minimum of 2 inches into fluid.

2. Fill sockets with a thermally conductive compound (grease or paste form), containing heat conducting additives.

3.3 PRESSURE-GAGE INSTALLATION

- A. Install pressure gages in piping tees with pressure-gage valve located on pipe at most readable position.
- B. Install dry-type pressure gages, except where liquid filled are indicated or required.
- C. Install liquid-filled-type pressure gages at suction and discharge of each pump and in other locations subject to strong fluid pulsations. Provide compound type liquid-filled gauges on the suction side of pumps.
- D. Install pressure-gage needle valve and snubber in piping to pressure gages.

3.4 TEST PLUG (P/T PORT) INSTALLATION

- A. Install test plugs in piping tees.
- B. Do not expose plugs to soldering, brazing or welding heat. Complete this work before installing the plugs.
- C. Install the plug horizontally or higher (top of pipe) to reduce contamination / plugging potential.

3.5 FLOW-MEASURING SYSTEM INSTALLATION

- A. Install flowmeters in accessible and most readable positions in piping systems.
- B. Install connection fittings for attachment to portable flowmeters in accessible locations.
- C. Assemble and install connections, tubing, and accessories according to manufacturer's written instructions.

3.6 DOMESTIC MAKE UP WATER METER INSTALLATION

- A. Install water meters at locations indicated on the Drawings.
 1. Install displacement-type water meters with shutoff valve on water meter inlet. Install valve on water meter outlet and valved bypass around meter.

3.7 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:

1. Install meters and gages adjacent to machines and equipment to allow service and maintenance.
- B. Install sight flow indicators on connections to bypass feeders and filters, and elsewhere as shown on the Drawings.

3.8 ADJUSTING AND CLEANING

- A. Calibrate meters according to manufacturer's written instructions, after installation.
- B. Adjust faces of meters and gages to proper angle for best visibility.
- C. Clean windows of meters and gages and clean factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION

SECTION 230523

GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes general duty valves common to several HVAC piping systems.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 23 piping Sections for specialty valves applicable to those Sections only.
 - 2. Division 23 Section "Identification for HVAC" for valve tags and charts.
 - 3. Division 23 Section "Instrumentation and Control for HVAC" for control valves and actuators.
 - 4. Division 23 Section "Hydronic Piping" for hydronic piping system component and equipment pressure ratings which apply to this Section, and for specialty valves.

1.3 DEFINITIONS

- A. The following are standard abbreviations for valves:
 - 1. CWP: Cold working pressure.
 - 2. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 3. PTFE: Polytetrafluoroethylene plastic.
 - 4. TFE: Tetrafluoroethylene plastic (e.g. Teflon®).
 - 5. TFM: Modified, 2nd-generation TFE.
 - 6. RPTFE: Reinforced Polytetrafluoroethylene plastic (e.g. reinforced Teflon®).

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For valves to include in the operation and maintenance manuals. Include detailed manufacturer's instructions on adjusting, servicing, disassembling, and repairing.

1.6 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.
- B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.
- C. NSF Compliance: NSF 61 for valve materials for potable-water service.
- D. MSS Compliance: Comply with the latest edition of various MSS Standard Practice documents referenced.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, and weld ends.
 - 3. Set ball valves open to minimize exposure of functional surfaces.
 - 4. Set butterfly valves closed or slightly open.
 - 5. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store indoors and maintain valve temperature higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use a sling to handle large valves. Rig to avoid damage to exposed parts. Do not use handwheels and stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1. Ball Valves (Hydronic / Water Services):
 - a. Conbraco Industries, Inc.; Apollo Division.
 - b. Jamesbury; a Div. of Metso Corp.

- c. NIBCO Inc.
 - d. Milwaukee Valve Company/ Hammond Valve
 - e. Stockham; a Div. of Crane Co.
2. Resilient Seated Butterfly Valves (Hydronic / Water Services):
- a. Bray International
 - b. Cameron DEMCO
 - c. J Flow Controls
 - d. Keystone; a Div. of Pentair PLC
 - e. NIBCO Inc.
 - f. Milwaukee Valve Company/ Hammond Valve
3. High Performance Butterfly Valves (Hydronic / Water Services):
- a. Bray International
 - b. Cameron WKM
 - c. Flowserve Corp.
 - d. J Flow Controls
 - e. NIBCO Inc.
 - f. Milwaukee Valve Company / Hammond Valve
 - g. Jamesbury; a Div. of Metso Corp.
4. Swing Check Valves:
- a. Bonney Forge Corp.
 - b. Milwaukee Valve Company / Hammond Valve
 - c. NIBCO Inc.
 - d. Stockham; a Div. of Crane Co.
 - e. Velan Inc.

2.2 BASIC, COMMON FEATURES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. Pressure and Temperature Ratings: Not less than as indicated elsewhere in this Section, and as required to suit system pressures and temperatures.
- C. Sizes: Same size as the pipe in which the valve is installed, unless otherwise indicated.
- D. Operators: Use the following operators and handwheels:
 - 1. Direct-Mount Handwheels: For valves other than quarter turn.
 - 2. Lever Handles: For quarter-turn valves 4 inches and smaller, where no more than 80 lbs. of force are required to fully open or close the valve
 - 3. Gear-Drive Operators: For quarter-turn valves 5 inches and larger, or where full closing or opening of the valve requires more than 80 lbs. of force. Gear-drive operator shall have a handwheel and a disc position/over-travel indicator to provide visual indication of disc position.

4. Chain-Wheel Operators: For valves 5 inches and larger, installed 96 inches or higher above finished floor elevation.
- E. Threads: ASME B1.20.1.
- F. Flanges: ASME B16.1 for cast iron, ASME B16.5 for steel, and ASME B16.24 for bronze valves.
- G. Solder Joint: ASME B16.18.
 1. Soldered joints are only permitted for ball valves. Solder joints are only permitted for ball valves with 6" long factory-provided copper extensions.
 2. Where soldered end connections are specified for valves with a resilient seat or disc, use solder having a melting point below 840 deg. F.

2.3 BALL VALVES (HYDRONIC / WATER)

- A. Ball Valves, 2 Inches and Smaller: MSS SP-110, 600-psi CWP, ASTM B 584 bronze body and bonnet, 2-piece construction; chrome-plated brass ball; full port; blowout proof bronze or brass stem; Teflon (PTFE) seats and seals; threaded end connections:
 1. Operator: Vinyl-covered carbon steel lever handle. Provide a lockshield where elsewhere specified or indicated on the Drawings.
 2. Stem Extension: For valves installed in insulated piping. The stem shall be enclosed in a protective sleeve that allows operation of valve without breaking the vapor seal to the sleeve or disturbing the insulation. The extension shall be 2" long.

2.4 RESILIENT SEATED BUTTERFLY VALVES (HYDRONIC / WATER)

- A. Resilient Seated Butterfly Valves, 2-1/2 inches and Larger (Hydronic Service Only): Concentric / zero-offset design, MSS SP-67, Class 150, 200-psi CWP dead-end service, bi-directional, ASTM A 126 cast-iron or ASTM A 395 ductile iron body with an extended stem and neck to receive insulation, stainless-steel stem, -lug style body with ANSI Class 150 tapped lugs and flange bolts. Bolts shall be installed at each side of the lugs to allow downstream piping to be disconnected. Stem to disc connection shall be of the geometric type (e.g. stem with square, hexagonal, or splined shape) or external pin type. Pins that penetrate both sides of the disc and create a potential leak path and set screws are not acceptable.
 1. Disc: Aluminum bronze.
 2. Seat: EPDM, minimum 225 deg F. continuous (250 deg F. intermittent) temperature rating in plain water, and compatible with ethylene and propylene glycols up to 210 deg F.
 3. Operator: As specified elsewhere in this Section.

2.5 HIGH PERFORMANCE BUTTERFLY VALVES (HYDRONIC)

- A. For Hydronic Services up to 210 deg. F.: MSS-SP-68, Class 150. Valve shall be of the double offset design. Guaranteed for bubbletight shutoff, high performance type, suitable for 285-psi CWP, complete with lug type carbon steel or 316 stainless steel body, and extended neck, and

with disc, seat retainer, shaft, bearings, and packing gland all constructed of Type 17-4PH, 316, or 317 stainless steel. Packing shall be PTFE. Seat shall be PTFE. Bodies shall be furnished with ANSI Class 150 tapped lugs and flange bolts to allow downstream piping to be disconnected leaving the valve in line to control the flow. Bolts shall be installed at each side of the lugs to allow downstream piping to be disconnected. - Stem to disc connection shall be of the geometric type (e.g. stem with square, hexagonal, or splined shape) or double external welded-in pin type. Pins shall be stainless steel. Single pins, pins that penetrate both sides of the disc and create a potential leak path, or pins that are not welded into place are not acceptable. Set screws are not acceptable.

2.6 SWING CHECK VALVES

A. Hydronic / Water Services:

1. Swing Check Valves, 2 Inches and Smaller: MSS SP-80; Class 150, 300-psi CWP; horizontal swing, Y-pattern, ASTM B 62 cast-bronze body and cap, rotating bronze disc with rubber seat or composition seat, threaded or soldered end connections:
2. Swing Check Valves, 2-1/2 Inches and Larger: MSS SP-71, Class 125, 200-psi CWP, ASTM A 126 cast-iron body and bolted cap, horizontal-swing bronze disc, flanged end connections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- C. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.
- F. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION

- A. Install valves as indicated, according to manufacturer's written instructions.

- B. Shut-Off Valve Orientation on Horizontal Piping: Unless recommended otherwise by the valve manufacturer, install ball and butterfly valves with their stems vertical, with the valve actuator on top. Where valves on insulated piping are not easily visible from below, provide an identifying label at the valve, on the bottom of the pipeline.
 - 1. Exception: Where space restrictions prevent reasonable access to the operator with a vertical stem orientation, or where chain wheels are required, valves may be installed with their stems horizontal (actuator on side of pipeline), or at an intermediate position between horizontal and vertical, but only if permitted by the valve manufacturer.
- C. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.
- D. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.
- E. Provide a union immediately downstream of threaded end valves.
- F. Locate valves for easy access and provide separate support where necessary.
- G. Install valves in a position to allow full stem movement.
- H. Installation of Check Valves: Install for proper direction of flow as follows:
 - 1. Swing Check Valves: Horizontal position with hinge pin level.
- I. Install valve tags and valve schedules as specified in Division 23 Section "Identification for HVAC".

3.3 SOLDERED CONNECTIONS

- A. Cut tube square and to exact lengths.
- B. Clean end of tube to depth of valve socket with steel wool, sand cloth, or a steel wire brush to a bright finish. Clean valve socket.
- C. Apply proper soldering flux in an even coat to inside of valve socket and outside of tube.
- D. Remove the cap and disc holder of swing check valves having composition discs.
- E. Insert tube into valve socket, making sure the end rests against the shoulder inside valve. Rotate tube or valve slightly to ensure even distribution of the flux.
- F. Apply heat evenly to outside of valve around joint until solder melts on contact. Feed solder until it completely fills the joint around tube. Avoid hot spots or overheating valve. Once the solder starts cooling, remove excess amounts around the joint with a cloth or brush.

3.4 THREADED CONNECTIONS

- A. Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.
- B. Align threads at point of assembly.
- C. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.
- D. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

3.5 FLANGED CONNECTIONS

- A. Align flange surfaces parallel.
- B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

3.6 VALVE END SELECTION

- A. Select valves with the following ends or types of pipe/tube connections:
 - 1. Copper Tube Size, 2 Inches and Smaller: Soldered or threaded ends.
 - 2. Steel Pipe Sizes, 2-1/2 Inches and Larger: Flanged or lugged.

3.7 APPLICATION SCHEDULE

- A. General Application (Hydronic Systems): Use ball and butterfly valves for shutoff duty; flow control valves and balancing cocks for throttling duty. Refer to piping system Specification Sections for specific valve applications and arrangements. Provide valves suitable for working pressures encountered in each system.
- B. Pressure and Temperature Ratings: If valves with specified pressure classes, SWP classes, or CWP ratings are unavailable, the same types of valves with higher classes or ratings may be substituted.
- C. Domestic Make-Up Water Systems: Use the following valve types:
 - 1. Ball Valves: 600-psi CWP, with stem extension.
 - 2. Butterfly Valves: Class 150.
 - 3. Check Valves: Class 125, swing type.
- D. Hydronic Heating Hot Water Systems: Use the following valve types:
 - 1. Ball Valves: 600-psi CWP, with stem extension.
 - 2. Resilient Seated Butterfly Valves: Class 150.

3. Check Valves: Class 150, bronze body swing check with rubber seat or Class 125, cast-iron body swing check.
4. Provide "spring-loaded "silent" check" valves at pumps as specified in Section "Hydronic Piping".

3.8 JOINT CONSTRUCTION

- A. Refer to Division 23 Section "Common Work Results for HVAC" for basic piping joint construction.
- B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.9 ADJUSTING

- A. Adjust or replace packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if leak persists.

END OF SECTION

SECTION 230529

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.
- B. Related Division 23 Sections include the following:
 - 1. "Common Work Results for HVAC" for metal fabrications for pipe and equipment supports.
 - 2. "Ductwork" for duct hangers and supports.

1.2 SUMMARY

- A. This Section includes hangers and supports for HVAC system piping and equipment.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.
- B. Terminology: As defined in ANSI / MSS SP-58.

1.4 PERFORMANCE REQUIREMENTS

- A. Design channel support systems for piping to support multiple pipes capable of supporting the combined weight of supported systems, system contents, and test water.
- B. Design heavy-duty steel trapezes for piping to support multiple pipes capable of supporting the combined weight of supported systems, system contents, and test water.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.

1.6 INFORMATIONAL SUBMITTALS

- A. Welding Certificates: Copies of certificates for welding procedures and operators.

1.7 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1. Pipe Hangers, Saddles, and Shields:
 - a. Anvil International, Inc.
 - b. Carpenter & Paterson, Inc.
 - c. Modern Pipe Hanger Co., Inc.
 - d. National Pipe Hanger Corp.
 - e. Penn Pipe Hanger Corp.
 - f. ERICO International Corporation.
 - 2. Channel Support Systems:
 - a. Anvil International, Inc.; Power-Strut Unit.
 - b. Carpenter & Paterson, Inc.
 - c. National Pipe Hanger Corp.
 - d. Thomas & Betts Corp.
 - e. Unistrut Corp.
 - f. ERICO International Corporation.
 - 3. Thermal-Hanger Shields and Shield Inserts:
 - a. Buckaroos Inc.
 - b. Carpenter & Paterson, Inc.
 - c. National Pipe Hanger Corp.
 - d. Pipe Shields, Inc.
 - e. Thermal Pipe Shields, Inc.
 - f. Value Engineered Products, Inc.
 - g. ERICO International Corporation.
 - 4. Drilled-In Mechanical Fastener Systems for Concrete:
 - a. Gunnebo Fastening Corp.
 - b. Hilti, Inc.
 - c. ITW Ramset/Red Head.

2.2 MANUFACTURED UNITS

- A. Pipe Hangers, Supports, and Components: ANSI / MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.
1. Galvanized, Metallic Coatings: For all piping hangers, supports, supplemental steel, hardware and accessories. All piping hangers, supports, hardware and accessories located outside shall be stainless steel or hot-dipped galvanized, no exceptions.
 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- B. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.
1. Coatings: Manufacturer's standard finish. All channel support systems and accessories exposed to weather shall be stainless steel or hot-dipped galvanized, no exceptions.
 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- C. Pipe Covering Protection Saddles: MSS Type 39, fabricated from carbon steel plate with edges rolled and ground smooth. Minimum length shall be 12". Depth of saddle shall be no less than the adjoining piping insulation thickness.
- D. Thermal-Hanger Shields and Shield Inserts: -High compressive-strength insulation, with an MSS Type 40 G90 galvanized sheet metal shield. Shield shall have rounded corners.
1. Insulation Material for Cold Piping: ASTM C 552, Type I cellular glass, or ASTM C 1126, Type III rigid phenolic foam with a minimum 3.75 PCF density.--. Insulation shall have a low perm (0.02 perm or less) all service jacket.
 2. Insulation Material for Hot Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate.
 3. Plenum Rating: Insulation shall have a flame spread index of less than 25, and a smoke developed index less than 50, when tested in accordance with ASTM E84-15a.
 4. Insulation Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.
 5. Insulation Thickness: Same thickness as adjoining piping insulation. Insulation shall span 360 degrees.
 6. Shield for Trapeze or Clamped System: Shield shall cover entire circumference of pipe (360 degrees).
 7. Shield for Clevis Hanger: Shield shall cover no less than the lower 180 degrees of pipe.
 8. Minimum Shield Lengths and Gauge:
 - a. Piping Sizes up to 3": 6" long and 20 gauge.
 - b. Additional thickness and length shall be provided as required to prevent more than 5% compression of insulation with the piping system filled.

2.3 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, galvanized. All structural steel members, plates, shapes, and bars exposed to weather shall be hot-dipped galvanized, no exceptions.
- B. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, non-shrink and nonmetallic, dry, hydraulic-cement grout.
 - 1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
 - 2. Properties: Non-staining, noncorrosive, and nongaseous.
 - 3. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger requirements are specified in Sections specifying equipment and systems.
- B. Refer to Division 23 Section "Vibration Controls for HVAC" for equipment and piping systems requiring vibration isolation hangers and supports.
- C. Comply with ANSI / MSS SP-58 and 127 for pipe hanger selections and applications that are not specified in piping system Specification Sections. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- D. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
- E. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- F. Use thermal-hanger shield inserts for insulated piping and tubing.
- G. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
 - 1. Modern Pipe Supports Corp. Figure 404, Government ring pipe clamp with Figure 540 turn buckle adjuster and threaded rod hanger.
 - 2. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if no insulation is specified / required.
 - 5. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 - 6. Clips (MSS Type 26): For support of insulated pipes on channel type and trapeze supports that are not subject to expansion or contraction.

7. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
 8. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
 9. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
 10. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 11. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 12. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- H. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- I. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- J. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where head room is limited.
- K. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification Sections, install factory fabricated saddles and shields of the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): Use only on hot steel piping without vapor barrier. Weld saddle to the steel pipe. Fill interior of saddle with the specified piping insulation.
 2. Protection Shields (MSS Type 40): Use on cold piping with vapor barrier, and all copper tubing. Length and metal thickness shall be as recommended by manufacturer to prevent crushing/compressing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, -insert of high-density, 100-psi minimum compressive-strength--- pipe insulation, same thickness as adjoining insulation with vapor barrier, with -a sheet metal shield.
- L. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 3. Spring Hangers for Piping 3" and Smaller:
 - a. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 - b. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
- M. Comply with ANSI / MSS SP-58 and 127 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- N. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

3.2 HANGER AND SUPPORT INSTALLATION - GENERAL REQUIREMENTS

- A. Hanging piping and equipment from roof and floor decking in steel framed buildings is prohibited. All equipment shall be hung from building steel structural system (e.g. steel beams and joists).
 - 1. Piping and equipment shall be supported directly from the building's steel beams or from miscellaneous structural steel provided by the Division 23 Contractor bearing on steel beams.
 - 2. Loads supported by steel bar joists exceeding 100 lbs. shall be located at the joist panel points, and shall not impose an eccentric load (twisting moment). Provide supplemental steel and align direct hanger connections to the joists with the joist centerline. Connect to the upper chord of the joist wherever it is possible to do so.
 - 3. Do not drill or cut building structural steel.
 - 4. Do not weld to building structural steel without explicit pre-approval from the Architect/Engineer. Repair fireproofing after welding.
- B. Pipe Hanger Installation: Comply with ANSI / MSS SP-58 and 127-. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- C. Trapeze Pipe Hanger (MSS Type 59) Installation: Comply with MSS SP-58 and 127-. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
 - 3. Threaded rods shall be minimum 3/8" size.
- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

- K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- M. Piping connections to boilers, coils, pumps and similar items shall be supported in such a manner that no pipe load is exerted on the vessel nozzles.
- N. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield or shield insert with clamp sized to match OD of insert.
 - 2. Install MSS SP-58, Type 39 pipe covering protection saddles, only on hot steel piping without vapor barrier.
 - a. Thermal-hanger shield inserts shall be used.
 - 3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier and on copper tubing. Shields shall span arc of at least 180 degrees with clevis hangers and roller supports, and 360 degrees with clamps.
 - a. Thermal-hanger shield inserts shall be used.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead.
- B. Fabricate structural steel stands to support equipment above floor where required or indicated on the Drawings. Where an equipment stand is not indicated or required, set equipment on concrete housekeeping pads no less than 4" high.
- C. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- D. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 WIND RESTRAINTS

- A. Gas Vent Restraints:
 - 1. Provide wind restraints to transmit wind loads from the gas vents to the building structural system.
 - 2. Wind restraints for all directions (transverse, longitudinal, and uplift) shall be provided at each gas vent support.

3. Restraints may take the form of guy wires and rigid elements.
4. Secure restraints to the gas vent system in accordance with the recommendations of the gas vent manufacturer.
5. Forces at moment connections to gas vents shall not exceed the gas vent manufacturer's recommended limits.

3.5 METAL FABRICATIONS

- A. Furnish and install miscellaneous iron work including, but not limited to, piping hangers, piping anchors and guides, and HVAC equipment supports. Additional structural members shall be furnished and installed to support the HVAC equipment without excessive stress or strain on the building construction. Structural beams and other structural members shall be furnished and installed under this Contract for anchors and guides where the building steel is not available or of sufficient size or weight to support or anchor pipe lines and equipment.
- B. Equipment and materials furnished and installed under this Contract which are not mounted on bases or floors shall be securely attached and supported from the main supporting structure of the building by metal hangers, clamps and/or brackets. Metal hangers, clamps and/or brackets shall be of suitable design and of sufficient strength to properly and safely support the materials and equipment involved.
- C. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.
 1. Where exterior structural steel members are cut, drilled or welded, or galvanizing is damaged, repair with a cold galvanizing repair compound with dry film containing not less than 93 percent zinc dust by weight, and complying with DOD-P-21035A or SSPC-Paint 20, as manufactured by ZRC Products Company, or equivalent.
- D. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.
- E. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 1. Welding shall be done by qualified welders certified as having fully complied with acceptable qualification tests as prescribed by a reputable testing agency using procedures approved by the American Welding Society.
 2. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 3. Obtain fusion without undercut or overlap.
 4. Remove welding flux immediately.
 5. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.6 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated or required slope of pipe.

- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches once the coordinated installations are complete. Any rod ends within 6'-8" of the finished floor shall be provided with rubber or vinyl screw thread caps and the piping or hanger marked with low clearance warning labels.

3.7 PAINTING

- A. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 230548

VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.
- B. Related Division 23 Sections include the following:
 - 1. "Hangers and Supports for HVAC Piping and Equipment" for pipe hanger restraints.
 - 2. "Ductwork" for hanger materials for ductwork.
 - 3. "Air Duct Accessories" for flexible duct connectors.
 - 4. Various Division 23 equipment specification sections for equipment requiring factory-furnished internal vibration isolation.

1.2 SUMMARY

- A. This Section includes vibration isolators.

1.3 ACTION SUBMITTALS

- A. Product Data: Indicate types, styles, materials, and finishes for each type of isolator specified. Include load - deflection curves.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

1.5 COORDINATION

- A. Coordinate layout and installation of vibration isolation devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate installation of equipment supports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1. Vibration Isolation Products:
 - a. BRD Noise and Vibration Control Inc.
 - b. Kinetics Noise Control Inc.
 - c. Mason Industries, Inc.
 - d. Novia Associates Inc.; a Div. of C&P
 - e. The VMC Group.
 - f. Vibration Eliminator Co., Inc.

2.2 VIBRATION ISOLATORS

- A. Isolator Pads: Oil and water resistant and factory cut to sizes that match requirements of the equipment supported.
 - 1. Rubber Isolator Pads: Elastomer (neoprene or silicone) arranged in single or multiple layers and molded with a nonslip ribbed or waffle pattern and with steel baseplates of sufficient stiffness to provide uniform loading over the pad area.
 - 2. Load Range: From 10 to 50 psig and a deflection not less than 0.08 inch per 1 inch of thickness. Do not exceed a loading of 50 psig.
- B. Spring Isolators: Freestanding, laterally stable, open-spring-type isolators.
 - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 3. Lateral Stiffness: More than 0.75 times the rated vertical stiffness. The spring diameter shall be no less than 0.8 of the compressed height of the spring at rated load.
 - 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 5. Baseplates: Factory drilled for bolting to structure and bonded to a 1/4-inch-thick, rubber isolator pad attached to the baseplate underside. Size baseplates to limit floor loading to 500 psig.
 - 6. Top Plates: Provide threaded studs for fastening and leveling equipment.
 - 7. Finishes: Baked enamel for metal components on isolators for interior use.
- C. Restrained Spring Isolators: Vertically restrained, freestanding, laterally stable, steel open-spring-type isolators.
 - 1. Housing: Welded steel with resilient vertical limit stops to prevent spring extension due to wind loads or when weight is removed. Factory-drilled baseplate for bolting to structure and bonded to a 1/4-inch-thick, rubber isolator pad attached to the baseplate underside. Provide adjustable equipment mounting and leveling bolt.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 0.75 times the rated vertical stiffness. The spring diameter shall be no less than 0.8 of the compressed height of the spring at rated load.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Finishes: Baked enamel for metal components on isolators for interior use.
- D. Spring Hangers: Combination spring and elastomeric hanger with coil spring and elastomeric insert in compression.
1. Frame: Formed steel, fabricated for connection to threaded rods and to allow for 30 degrees of angular hanger rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 5. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 6. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 7. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.
 8. Finishes: Baked enamel for metal components. Color-code to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS AND INSTALLATION

- A. General: Except as otherwise indicated*, select vibration control products in accordance with ASHRAE Handbook, 2015 Edition of HVAC Applications Volume, Chapter 48 "Noise and Vibration Control", including Table 47. Where more than one type of product is recommended in Table 47, the selection is the Contractor's option so long as that type of product is specified in this Section.

1. Exceptions:
 - a. Type 3 (spring) hangers and mounts shall be used where Type 2 (rubber) hangers and mounts are indicated in Table 47.
 - b. *Specific indications on the Drawings or in an equipment specification Section elsewhere in Division 23 shall take precedence over the above referenced chapter of the ASHRAE HVAC Applications Handbook.
 - B. All rotating, vibrating, and motor driven equipment shall be provided with field applied vibration isolation from one of the manufacturers listed elsewhere in this Section, except the following:
 1. Where internal isolation has been provided as part of the factory-manufactured equipment package. The isolator products used shall comply with this Section, and other specific indications in the Contract Documents, including type and minimum amount of static deflection.
 - C. Vertical Restraints: Vibration isolators shall be of the restrained type incorporating a vertical limit stop when applied to all equipment subject to weight changes during operating or maintenance activities, such as when water is drained from the equipment (e.g. chillers, cooling towers, etc.).
 - D. Install and anchor vibration-control products according to manufacturer's written instructions and authorities having jurisdiction.
 - E. Anchor interior mounts, isolators, and hangers to vibration isolation bases. Bolt isolator baseplates to structural floors as required by authorities having jurisdiction.
 - F. Installation of vibration isolators shall not cause any change of position of equipment, piping or duct work resulting in stresses or misalignment.
 - G. Equipment isolators and bases shall be dedicated to a single piece of vibrating equipment.
 - H. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified. Coordinate work with other trades to avoid rigid contact with the building elements or the work of other trades.
 - I. Locate isolation hangers as near to the overhead support structure as possible.
 - J. Provide flexible duct connectors on duct connections to fan-containing equipment as specified in Division 23 Section "Air Duct Accessories".
- 3.3 ADJUSTING
- A. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operations.

END OF SECTION

SECTION 230553

IDENTIFICATION FOR HVAC

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes HVAC identification materials and devices.

1.3 ACTION SUBMITTALS

- A. Product Data: For identification materials and devices.

1.4 INFORMATIONAL SUBMITTALS

- A. Samples: Of color, lettering style and graphic representation required for each identification material and device.
- B. Piping and Ductwork System Labeling Scheme: For each duct and piping system.
- C. Equipment Labeling Scheme: For each scheduled piece of equipment on the project.
- D. Valve Tagging Scheme: For each piping system.

1.5 CLOSEOUT SUBMITTALS

- A. Valve Schedules: For each piping system. Reproduce on standard-size bond paper. Tabulate valve number, piping system, system abbreviation as shown on tag, room or space location of valve, type of valve, valve normal position, and variations for identification. Mark valves intended for emergency shutoff and similar special uses. In addition to the building wall mounted copies, furnish copies for maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Coordinate colors, abbreviations, and similar features with the Client Agency's existing marking and labeling systems and match existing installations.

1.7 SEQUENCING AND SCHEDULING

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1. Almetek Industries Inc.
 - 2. Bunting
 - 3. Craftmark Pipe Markers
 - 4. EMED Co.
 - 5. Kolbi Pipe Marker Co.
 - 6. Marking Services, Inc.
 - 7. Seton Identification Products
 - 8. W.H. Brady Corp.

2.2 IDENTIFYING DEVICES AND LABELS

- A. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive, vinyl type with permanent adhesive.
 - 1. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers, extending 360 degrees around pipe at each location.
 - 2. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers, at least 3 times letter height and of length required for label.
 - 3. Lettering: Manufacturer's standard preprinted captions as selected by Architect, and approved by the Client Agency. Letters shall be no smaller than 1-1/2-inches high.
 - 4. Arrows: Either integrally with piping system service lettering, to accommodate both directions, or as separate unit, on each pipe marker to indicate direction of flow.
- B. Plastic Duct Markers: Manufacturer's standard laminated plastic.
 - 1. Color Coding:
 - a. Blue: Air supply.
 - b. Green: Outside, return, and mixed air.
 - c. Yellow: Exhaust air.
 - d. Hazardous Exhaust: As specified by ASME A13.1.

2. Terminology and Lettering: Include direction of airflow; duct service such as supply, return, or exhaust and size of duct.
 - a. Letters shall be no smaller than 1-1/2-inches high.
- C. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive, vinyl tape, at least 3 mils thick.
 1. Width: 1-1/2 inches on pipes with OD, including insulation, less than 6 inches; 2-1/2 inches for larger pipes.
 2. Color: Comply with ASME A13.1, unless otherwise indicated.
- D. Ductwork Stencils: With clean cut symbols and letters no smaller than 2-1/2" tall. Paint shall be semi- gloss enamel, with colors conforming to the color coding specified above for plastic duct markers, except black shall be used instead of yellow.
- E. Plastic Equipment Labels and Signs: Manufacturer's standard laminated plastic, in the following color codes:
 1. Green: Cooling equipment and components.
 2. Yellow: Heating equipment and components.
 3. Brown: Energy reclamation equipment and components.
 4. Blue: Equipment and components that do not meet criteria above.
 5. Hazardous Equipment: Use colors and designs recommended by ASME A13.1.
 6. Text Size: Letter height shall be no less than 1/4-inch.
- F. Plasticized Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with mat finish suitable for writing.
 1. Size: 3-1/4 by 5-5/8 inches.
 2. Fasteners: Brass grommets and wire.
 3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
 4. Color: Yellow background with black lettering.
- G. Access Panel Markers: Manufacturer's standard laminated plastic, adhesive backed,-- - with abbreviated terms and numbers corresponding to concealed item. -Black lettering on a white background. Letter height shall be no less than 1/4-inch.

PART 3 - EXECUTION

3.1 GENERAL

- A. Walking / head clearance hazards in mechanical room such as horizontal runs of piping or ductwork less than 6'-8" above the finished floor shall be identified according to ANSI Z535 OSHA standards.
- B. Tripping hazards in mechanical rooms shall be identified according to ANSI Z535 and OSHA standards.

- C. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification with corresponding designations indicated on the Drawings. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of mechanical systems and equipment.
 - 1. Multiple Systems: Identify individual system number and service if multiple systems of same name are indicated.
- D. Degrease and clean surfaces to receive adhesive of identification materials.
- E. Prepare surfaces in accordance with Division 09 provisions for stencil painting.
- F. Warning-Tag Installation: Write required message on, and attach warning tags to, equipment and other items where required by OSHA standards.

3.2 LABELING AND IDENTIFYING PIPING SYSTEMS

- A. Install pipe markers on each system. Include arrows showing normal direction of flow.
- B. Marker Type: Plastic markers, with application systems. Install on pipe insulation segment where required for hot, noninsulated pipes.
- C. Fasten markers on pipes and insulated pipes smaller than 6 inches in diameter by one of following methods:
 - 1. Adhesive lap joint in pipe marker overlap.
 - 2. Laminated or bonded application of pipe marker to pipe or insulation.
 - 3. Taped to pipe or insulation with color-coded plastic adhesive tape, not less than 3/4 inch wide, lapped a minimum of 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
- D. Fasten markers on pipes and insulated pipes 6 inches in diameter and larger by one of following methods:
 - 1. Laminated or bonded application of pipe marker to pipe or insulation.
 - 2. Taped to pipe or insulation with color-coded plastic adhesive tape, not less than 1-1/2 inches wide, lapped a minimum of 3 inches at both ends of pipe marker, and covering full circumference of pipe.
 - 3. Strapped to pipe or insulation with manufacturer's standard stainless-steel bands.
- E. Locate pipe markers and color bands where piping is exposed in finished spaces; mechanical rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior non-concealed locations according to the following:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for terminal units. Mark each pipe at branch, where flow pattern is not obvious.
 - 3. Near penetrations through walls, floors, ceilings, or nonaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.

6. Spaced at a maximum of 50-foot intervals along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings, except omit intermediately spaced markers.
 8. Provide identification labels at ceiling tiles to locate valves above removable acoustical ceilings.
 9. Provide identification labels at access panels to locate concealed valves.
- F. Do NOT label piping where exposed in finished spaces.
- G. For glycol containing closed loop hydronic systems, tag all system drain valves with tags reading "Contains Glycol - DO NOT DRAIN".

3.3 VALVE TAGS

- A. Install on valves in piping systems, except check valves, valves within factory-fabricated equipment units, and HVAC terminal devices and similar roughing-in connections of end-use units/equipment which are within line of sight of such units/equipment. List tagged valves in a valve schedule. Mount the valve schedule to the wall where directed by the Architect / Engineer or the Client Agency.
1. Provide labels on piping insulation / jacketing at check valves and unions so their locations can be identified afterwards.
- B. Install framed valve schedule in each major equipment room, in locations selected by the Client Agency.
- C. Control valves and balancing valves shall be provided with a plastic tag with the design GPM and final balance GPM value written in permanent marker. The tag shall be secured to the valve.

3.4 EQUIPMENT SIGNS AND LABELS

- A. Equipment Signs and Labels: Install and permanently fasten equipment nameplates on HVAC equipment. Locate nameplates where accessible and visible.
1. Include signs and labels for all equipment and devices scheduled or tagged on the Drawings.
 2. Terminology: Match schedules as closely as possible. Include the following:
 - a. Name and plan number.
 - b. Equipment service.
 - c. Design capacity.
 - d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.
 - e. Regularly required maintenance actions for equipment and systems, including the title or publication number for the operation and maintenance manual for that particular model and type of product, as required by the 2018 International Energy Conservation Code.

- B. Provide warning labels or tags in a conspicuous location on all electrically powered equipment that reads "DANGER - LOCK OUT ELECTRICITY BEFORE WORKING ON EQUIPMENT".

3.5 LABELING AND IDENTIFYING DUCTWORK SYSTEMS

- A. Identify all ducts with duct markers; or provide stenciled signs and arrows indicating service and direction of flow.
 - 1. Location: Locate signs near points where ducts enter into concealed spaces, at all access panels and doors, on both sides of floor and wall penetrations, below roof penetrations, at all major changes in direction, and at maximum intervals of 30 feet.
 - 2. Label duct access doors with laminated plastic, adhesive backed markers. Text shall indicate the purpose of the door (e.g. "Fire Damper", "Inspection and Cleaning Access", etc.).
 - 3. Ducts and duct access doors exposed in finished areas shall NOT be labeled.

3.6 ADJUSTING AND CLEANING

- A. Relocate mechanical identification materials and devices that have become visually blocked by work of this or other Divisions.
- B. Clean faces of identification devices and glass frames of valve charts.

END OF SECTION

SECTION 230593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes testing, adjusting, and balancing HVAC systems, including the following:
 - 1. Air Systems:
 - a. Constant-volume air systems.
 - 2. Hydronic Piping Systems:
 - a. Constant-flow systems.
 - 3. Testing, Adjusting, and Balancing of Equipment, including, but not limited to:
 - a. Motors.
 - b. Fans, and fan-containing equipment.
 - c. Pumps.
 - d. Boilers.
 - e. Heat-transfer coils.
 - 4. HVAC equipment quantitative-performance settings.
 - 5. Diffuser and grille supply pattern adjusting.
 - 6. Reporting results of activities and procedures specified in this Section.
- B. Related Sections include the following:
 - 1. Testing and adjusting requirements unique to particular systems and equipment are included in the Sections that specify those systems and equipment.
 - 2. Field quality-control testing to verify that workmanship quality for system and equipment installation is specified in system and equipment Sections.

1.3 ACCEPTABLE TESTING AND BALANCING AGENTS

- A. Subject to compliance with requirements, engage one of the following TAB Agents to perform the work of this Section:

1. Air Balancing Engineers Inc. (Berwick PA)
2. Baltronix Inc. (Langhorne PA)
3. Flood and Sterling Inc. (New Cumberland PA)
4. Peno Balancing Co. Inc. (Centre Hall PA)
5. TABworks Inc. (Hershey PA)

1.4 DEFINITIONS

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. Airflow Control Terminal: Device installed in the duct system that automatically regulates the airflow rate passing through the device. (e.g. VAV boxes, air valves, etc.)
- C. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.
- D. Deficiency: Any installation, measurement, or finding outside the tolerances allowed by the referenced testing and balancing procedural standards or project specifications.
- E. Diversity: In air or hydronic systems, diversity is the term used to describe the difference in air or water volume between the prime mover (fan or pump) and sum of the terminal elements.
- F. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
- G. Memory Stop: An adjustable mechanical device that allows a valve to be closed (for service) and limits the valve to a predetermined position when re-opened.
- H. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- I. Report Forms: Test data sheets for recording test data in logical order.
- J. Shutoff Head: The dynamic measurement of a pump's total dynamic head at no flow. Performed by closing the pump discharge valve only.
- K. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
- L. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- M. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- N. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

- O. TAB (Testing, Adjusting, and Balancing): A systematic process or service applied to HVAC systems, and other environmental systems, to achieve and document air and hydronic flow rates.
- P. TAB Agent: The contractor performing the work of this Section.
- Q. Terminals: In the context of a hydronic system, a device such as a coil where heat is either removed or added to the working fluid, other than the system prime movers (chillers, cooling towers, boilers, etc.).
- R. Terminal Outlet or Inlet: A point where air enters or leaves the ductwork distribution system. (e.g. diffuser, register, grille, etc.)
- S. Test: A procedure to determine quantitative performance of a system or equipment.
- T. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.
- U. AABC: Associated Air Balance Council.
- V. AMCA: Air Movement and Control Association.
- W. NEBB: National Environmental Balancing Bureau.
- X. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.5 INFORMATIONAL SUBMITTALS

- A. Certified Testing, Adjusting, and Balancing Reports: Submit reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.
- B. Sample Report Forms: Submit sample testing, adjusting, and balancing report forms.

1.6 CLOSEOUT SUBMITTALS

- A. Warranty: Submit 2 copies of special warranty specified in the "Warranty" Article below.

1.7 QUALITY ASSURANCE

- A. Agent Qualifications: Engage a testing, adjusting, and balancing agent that is currently certified by either AABC or NEBB.
 - 1. The company / agency as a whole shall be certified, and at least one individually certified supervisor or technician shall be supervising or participating in the work at the project site at all times when testing and balancing activities are taking place.
 - 2. The individually certified supervisor or technician shall be a AABC "TBE" or NEBB Certified with a minimum of eight (8) years' experience in performing HVAC system testing, adjusting and balancing, with at least four (4) of those years in a supervisory position.

3. At least one of the on-site certified supervisors or technicians shall have performed work characteristic of this project on at least three (3) other similar projects within the last five (5) years.
- B. Sub-Contracting Arrangement: The Agent shall be an independent company that is not financially affiliated with the Division 23 Contractor.
- C. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:
 1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
 2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.
- D. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC's "National Standards for Testing, Adjusting, and Balancing" or from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems".
- E. Instrumentation Type, Quantity, and Accuracy: As described in AABC national standards or in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification".
- F. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.8 COORDINATION

- A. The Division 23 Contractor shall coordinate the efforts of factory-authorized service representatives for systems and equipment, ATC System Installer, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.
- B. Notice: Provide 7 days' advance notice for each test. Include scheduled test dates and times.
- C. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.9 WARRANTY

- A. General Warranty: The project performance guarantee specified in this Article shall not deprive the Client Agency of other rights the Client Agency may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Project Performance Guarantee: Provide a guarantee on AABC'S "National Standards" forms or on NEBB forms stating that AABC or NEBB will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing Agent fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified Agent has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.
3. The warranty shall meet the requirements of the following program(s):
 - a. AABC - National Project Performance Guarantee
 - b. NEBB - Conformance Certification

PART 2 - PRODUCTS

2.1 DUCT TEST HOLES AND HOLE PLUGS

- A. Refer to Division 23 Section "Air Duct Accessories" for instrument test holes for ducts constructed to pressure classes exceeding 2" w.g. positive pressure, and for ducts of welded seam and joint construction.
 1. The TAB Agent shall review the Division 23 Contractor's ductwork shop drawings and shall prescribe the location, spacing, and quantity of all required instrument test holes.
- B. For ducts not utilizing welded seam and joint construction and for those constructed for 2" w.g. positive pressure class or less, the TAB Agent shall provide tapered, round LDPE plastic plugs with center pull-tabs to seal holes drilled in ductwork for measuring purposes. Provide Caplugs "CPT" series or approved equal. Holes drilled in ducts shall be no larger than 1/2" diameter.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.
 1. Verify that balancing devices, such as balancing valves and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
 2. Identify locations where instrument test holes are required and coordinate with the sheet metal shop drawings and coordination drawings so that the required test holes are installed prior to beginning testing and balancing operations.
- B. Examine approved submittal data of HVAC systems and equipment.
 1. Verify the balancing and/or flow verification requirements of the equipment provided with the manufacturers or manufacturer's representatives.
 2. Electrically commutated motors (ECMs) and automatic flow balancing / flow-limiting valves are examples of equipment which often require non-standard balancing and flow measurement / verification approaches.

- C. Examine equipment performance data, including fan and pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 1. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.
- D. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.
- E. Examine system and equipment test reports.
- F. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as balancing valves and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- G. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- H. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- I. Examine strainers for clean screens and proper perforations.
- J. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- K. Examine equipment for installation and for properly operating safety interlocks and controls.
- L. Examine system pumps to ensure absence of entrained air in the suction piping.
- M. Examine automatic temperature system components to verify the following:
 - 1. Dampers , valves, and other controlled devices operate by the intended controller.
 - 2. Dampers and valves are in the position indicated by the controller.
 - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions.
 - 4. Automatic modulating control valves are properly connected.
 - 5. Thermostats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 - 6. Sensors are located to sense only the intended conditions.
 - 7. Sequence of operation for control modes is according to the Contract Documents.
 - 8. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
 - 9. Interlocked systems are operating.
 - 10. Changeover from heating to cooling mode occurs according to design values.

- N. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

3.2 PREPARATION

- A. Complete system readiness checks. Verify, at the minimum, the following:

1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance dampers are open.
6. Fire and smoke dampers are open.
7. Balancing valves are open and control valves are operational.
8. Ceilings are installed in areas where air-pattern adjustments are affected by the ceiling.
9. Air terminal inlets and outlets (grilles, diffusers, etc.) have been fitted with their specified accessories, such as dampers, neck baffles, and control grids, and have been adjusted to the required throw pattern.
10. Access to balancing devices is provided.
11. Windows and doors can be closed so design conditions for system operations can be met.
12. Variable-frequency controller startup is complete and safeties are verified.
13. Fans are operating, free of vibration, and rotating in the correct direction.
14. Strainers are pulled and cleaned.
15. Shut-off and balancing valves are verified 100% open.
16. Control Valves shall be provided with a plastic tag with the design GPM and final balance GPM value written in permanent marker . The tag shall be secured to the valve.
17. Pumps are started and proper rotation is verified.
18. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in the latest edition of AABC's "National Standards for Total System Balance" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", and this Section.
 1. The content of this Section shall be considered supplemental to the referenced standards, however in the event of a direct conflict between this Section and the referenced standards, the referenced standards shall take precedence.
- B. Access and Repair: Cut insulation on ducts , pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes as specified elsewhere in this Section and patch insulation and jacketing with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.

- C. Final Setting Marks: Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions , valve indicators , fan-speed-control levers, and similar controls and devices, to show final settings.
- D. Provide all instruments, equipment, and materials needed for tests.

3.4 RE-TESTING

- A. If any deficiency in the installation of the work discovered during initial TAB operations prevents complete, accurate, and uncompromised testing, adjusting, and balancing of the systems, the TAB Agent shall report the deficiencies in writing. Any preliminary balancing work done with the deficiency still present shall will not be sufficient for acceptance, and re-testing and balancing shall be required after the deficiency has been fully corrected by the Contractor.
- B. If the fan and motor sheaves furnished with the fan prove to be inadequate for properly balancing the fan, the Division 23 Contractor shall replace the sheaves at no additional Cost to the Client Agency, and the TAB agent shall re-test and balance the fan with the new sheaves.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
 - 1. Do not use readouts from airflow measuring stations as report data. The Agent shall independently measure airflow rates.
- D. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check dampers for proper position to achieve desired airflow path.
- H. Check for airflow blockages.
- I. Check for proper sealing of air-handling unit components.
- J. Check for proper sealing of air duct system.
- K. Place systems in operation with filters installed and control systems complete and operating. Temporarily block filters to simulate dirty filter pressure drop (obtain dirty filter pressure drop from drawing schedules. If not stated, contact design engineer to obtain). Balance systems to design ratings.

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure fan static pressures to determine actual static pressure as follows:
 - a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
 - 3. Compare contractor document values with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
 - 4. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
 - 5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.
- B. Where present, adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 - 1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets (e.g. grilles and diffusers) and calculate the total airflow for that zone.
 - 2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure terminal outlets and inlets without making adjustments.
 - 1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

- D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminal inlets and outlets.
 - 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 - 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 - 1. Open all manual valves for maximum flow.
 - 2. Check makeup-water-station pressure gage for adequate pressure for highest vent.
 - 3. Set system controls so automatic valves are wide open to coils and heat exchangers.
 - 4. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 - 5. Check air vents for a forceful liquid flow exiting from vents when manually operated.
 - 6. Verify that air has been purged from the system.
- D. For auto-balancing valves, and pressure-independent control valves (PICVs), record differential pressure with auto-balancing valve throttling against maximum flow.
- E. For 3-way control valves, balance "bypass" flow to match "through" flow, if a calibrated manual balancing valve is shown on the bypass piping. The "through" flow shall be balanced first, with the control valve positioned for zero coil bypass. The "bypass" flow shall be balanced second, with the control valve positioned for full coil bypass.
- F. For pumps powered through variable frequency drives, set the maximum output frequency of the drive to a speed that results in operation of the motor at 95% of the motor nameplate ampacity. Note that this will often be above 60 Hz. Refer to Division 23 Section "Common Motor Requirements for HVAC Equipment" for additional information related to variable frequency drive tests and setting adjustments.

3.8 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

- A. Adjust pumps to deliver total design gpm.
 - 1. Measure total water flow.
 - a. Position valves for full flow through coils.

- b. Measure flow by main flow meter, if installed.
 - c. If main flow meter is not installed, determine flow by pump TDH or boiler or heat exchanger pressure drop.
 2. Measure pump TDH as follows:
 - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - c. Convert pressure to head and correct for differences in gage heights.
 - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
 - e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
- B. Adjust flow-measuring and balancing devices installed in mains and sub-main branches to design water flows.
 1. Measure flow in main and branch pipes.
 2. Adjust main and branch balance valves for design flow.
 3. Re-measure each main and branch after all have been adjusted.
- C. Adjust flow-measuring and balancing devices installed at coils and terminal units (e.g. fin tube radiators, VAV box coils, fan coils, unit heaters, etc.) for each space to design water flows.
 1. Measure flow at terminals.
 2. Adjust each terminal to design flow.
 3. Re-measure each terminal after it is adjusted.
 4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 5. Perform temperature tests after flows have been balanced.
- D. For systems with pressure-independent valves or automatic flow-control / flow limiting valves at terminals:
 1. Verify flow at each terminal by measuring differential pressure across the pressure-independent valve to verify that it is within the valve manufacturer's specified range.
 2. Perform terminal temperature tests after flows have been verified. Command pressure independent control valves through the BAS to the full open position - do not manually open pressure independent valves.
- E. Verify final system conditions as follows:
 1. Re-measure and confirm that total water flow is within design.
 2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 3. Mark final settings.

- F. Verify that memory stops have been set.

3.9 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

3.10 PROCEDURES FOR BOILERS

- A. If hydronic, measure entering- and leaving-water temperatures, water flow, and relief valve setting.

3.11 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Water Coils: Measure the following data for each coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

3.12 DIFFUSER AND GRILLE SUPPLY PATTERN ADJUSTING

- A. Minimizing Drafts - Adjust all supply outlet diffusers, grilles, and registers to minimize drafts in all areas. Generally, this should consist of the following:

1. Adjust drum louvers, wall and duct mounted bar grilles and slot diffusers, and similar supply outlets as follows:
 - a. Adjust the horizontal spread provide full coverage across the occupied space, and to minimize the strength of the draft at the end of the jets.
 - b. For interior spaces or spaces with only roof exposure, adjust the vertical spread upwards to ensure that the supply jet does not fall into the occupied space before decaying to below 50 feet per minute. Perform measurements using a velocimeter, adjust, and retest until this criteria is met. Perform the above mentioned horizontal spread adjustments before adjusting the vertical pattern.
 - c. For exterior spaces, adjustment shall be made to provide the most nearly-horizontal pattern that still ensures the supply air jet reaches the occupied zone during

conditions of peak or near-peak heating (i.e. during the warmest supply air condition).

2. Verify that ceiling supply diffusers indicated on the drawings for 1, 2, or 3-way patterns achieve the required throw directions. Re-arrange and adjust louvers and deflectors as required. For some styles of diffusers, this will require verifying that the diffusers have the required sectorizing baffles installed.

- B. Adjustments shall be made to prevent drafts on space temperature sensors controlling heating and cooling equipment.

3.13 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Fans and Equipment with Fans: Zero to plus 10 percent, when tested with filter pressure drop simulated at dirty conditions.
2. Air System Minimum Outdoor Air Intake: 100% to 110% of design.
3. Air Outlets and Inlets (Diffusers and Grilles): Minus 10 percent to plus 10 percent.
4. Hydronic Flow Rate: Zero to minus 5 percent.

3.14 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of instruments used for procedures, along with proof of calibration.

- C. Final Report Contents: In addition to report data specified in paragraphs below, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.
6. All required measurements described in Articles above, but not listed in paragraphs below.

- D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of TAB firm.
3. Project name.
4. Project location.

5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB firm who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 12. Nomenclature sheets for each item of equipment.
 13. Data for airflow control terminal units, including manufacturer, type size, and fittings.
 14. Notes to explain why certain final data in the body of reports varies from indicated values.
 15. Test conditions for fans and pumpperformance forms including the following:
 - a. Settings for outside-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Fan drive settings including settings and percentage of maximum pitch diameter.
 - d. Settings for supply-air static-pressure controller.
 - e. Other system operating conditions that affect performance.
- E. Airflow and water flow measurement device verification and calibration result test reports.
- F. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outside, supply, return, and exhaust airflows.
 2. Water flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Airflow control terminal units.
 6. Airflow terminal inlets and outlets.
 7. Balancing stations.
 8. Position of balancing devices.
- G. DOAS Unit and Similar Air System Equipment Test Reports: For -air systems with heat transfer devices (coils, etc.) include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Sheave dimensions, center-to-center, and amount of adjustments in inches.

- j. Number of belts, make, and size.
 - k. Number of filters, type, and size.
2. Motor Data:
- a. Make and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
3. Air-Side Test Data (Indicated and Actual Values), with pressures and airflow rates presented on a diagram of the unit:
- a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat coil static-pressure differential in inches wg.
 - g. Cooling coil static-pressure differential in inches wg.
 - h. Re-heating coil static-pressure differential in inches wg.
 - i. Outside airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outside-air damper position.
 - l. Return-air damper position.
- H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
- a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Sheave dimensions, center-to-center, and amount of adjustments in inches.
2. Motor Data:
- a. Make and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - g. Number of belts, make, and size.

3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.

- I. Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 1. Report Data:
 - a. System, fan and air-handling unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft..
 - g. Indicated airflow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.

- J. Air-Terminal-Device Reports (Grilles, Diffusers, etc.):
 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Test apparatus used.
 - d. Area served.
 - e. Air-terminal-device make.
 - f. Air-terminal-device number from system diagram.
 - g. Air-terminal-device type and model number.
 - h. Air-terminal-device size.
 - i. Air-terminal-device effective area in sq. ft..

 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary airflow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final airflow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.

K. Duct-System Hydronic- Coil Reports: For duct-mounted reheat coils and water re-heat coils of airflow control terminal units (e.g. VAV boxes), include the following:

1. Unit Data:
 - a. Associated system and air-handling unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flow measurement method.
2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in deg F.
 - f. Leaving-air temperature in deg F.

L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model and serial numbers.
 - f. Water flow rate in gpm.
 - g. Water pressure differential in feet of head or psig.
 - h. Required net positive suction head in feet of head or psig.
 - i. Pump rpm.
 - j. Impeller diameter in inches.
 - k. Motor make and frame size.
 - l. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.
2. Test Data (Indicated and Actual Values):
 - a. Static head in feet of head or psig.
 - b. Pump shutoff pressure in feet of head or psig.
 - c. Actual impeller size in inches.
 - d. Full-open flow rate in gpm.
 - e. Full-open pressure in feet of head or psig.
 - f. Final discharge pressure in feet of head or psig.
 - g. Final suction pressure in feet of head or psig.
 - h. Final total pressure in feet of head or psig.

- i. Final water flow rate in gpm.
- j. Voltage at each connection.
- k. Amperage for each phase.

M. Boiler Test Reports:

1. Unit Data:

- a. Unit identification.
- b. Location.
- c. Service.
- d. Make and type.
- e. Model and serial numbers.
- f. Voltage at each connection.
- g. Amperage for each phase.

2. Test Data (Indicated and Actual Values):

- a. Operating pressure in psig.
- b. Operating temperature in deg F.
- c. Entering-water temperature in deg F.
- d. Leaving-water temperature in deg F.
- e. Number of safety valves and sizes in NPS.
- f. Safety valve settings in psig.
- g. High-limit setting in psig.
- h. Operating-control setting.
- i. High-fire set point.
- j. Low-fire set point.
- k. Voltage at each connection.
- l. Amperage for each phase.
- m. Draft fan voltage at each connection.
- n. Draft fan amperage for each phase.
- o. Manifold pressure in psig.

N. Air-to-Air Heat-Recovery Heat Exchanger (Energy wheel, heat pipe, etc.) Reports: As a supplement to the report for the air handling unit, etc. in which the air to air heat recovery heat exchanger is installed, include the following:

1. Energy Recovery Heat Exchanger Data:

- a. Unit identification.
- b. Location.
- c. Service.
- d. Make and type.
- e. Model and serial numbers.

2. Energy Recovery Heat Exchanger Test Data (Indicated and Actual Values):

- a. Total exhaust airflow rate in cfm.
- b. Purge exhaust airflow rate in cfm.
- c. Outside airflow rate in cfm.

- d. Total exhaust fan static pressure in inches wg.
- e. Total outside-air fan static pressure in inches wg.
- f. Pressure drop on each side of recovery wheel in inches wg.
- g. Exhaust air temperature entering in deg F.
- h. Exhaust air temperature leaving in deg F.
- i. Outside-air temperature entering in deg F.
- j. Outside-air temperature leaving in deg F.
- k. Calculate sensible and total heat capacity of each airstream in MBh.

O. Instrument Calibration Reports:

- 1. Instrument type and make.
- 2. Serial number.
- 3. Application.
- 4. Dates of use.
- 5. Dates of calibration.

3.15 ADDITIONAL TESTS

- A. After acceptance of the final balancing report, and within one year of substantial completion, provide up to 8 hours of on-site time for additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions. This allowance may be required over as many as two (2) separate site visits. "Additional testing and balancing" meaning work not otherwise required by the Contract Documents.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

SECTION 230716

HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes blanket, board, and block insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

1.3 ACTION SUBMITTALS

- A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed a craft training program offered by the Contractor, insulation material manufacturer, or trade association relating to the installation of equipment insulation for commercial, industrial and institutional applications. Installers shall also have no less than one (1) year of relevant experience.
- B. Installation Standards: The application of insulation shall conform to the Midwest Insulation Contractors Association's (MICA) "National Commercial and Industrial Insulation Standards", 8th Edition, except where the content of this Section conflicts.
- C. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
 - 1. Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.

2. Materials used outside the building are exempt from the above requirement.

- D. Minimum Insulation Thicknesses and R-Values: Conform to requirements of ASHRAE Standard 90.1- 2016 and the 2015 International Energy Conservation Code (IECC), or the requirements of this Section, whichever is most demanding.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.
- B. Protect materials from dirt and water. If insulation materials are dirtied or wetted, they shall not be installed, or shall be removed from the equipment if wetted or soiled after installation.

1.7 COORDINATION AND SCHEDULING

- A. Coordinate clearance requirements for insulation application during the preparation of shop drawings and coordination drawings, and during equipment installation.
- B. Schedule the application of insulation on cold / below-ambient piping systems, and associated equipment, to occur during the winter months, or with the cooling system de-energized. Substrates shall be completely dry at the time of application. Do not restore cooling service until the insulation installation is complete.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
1. Glass Mineral-Fiber Insulation:
 - a. CertainTeed Corp.
 - b. Johns Manville Corp.
 - c. Knauf Insulation
 - d. Manson Insulation Inc.
 - e. Owens-Corning Fiberglas Corp.
 2. Flexible Elastomeric Thermal Insulation:
 - a. Armacell LLC (Type AP Armaflex).
 - b. K-Flex USA
 - c. AeroFlex USA
 3. PVC Jackets:
 - a. Speedline

- b. Johns Manville
 - c. Knauf Insulation
 - d. Proto Corp.
4. Aluminum Jackets:
- a. ITW Insulation Systems
 - b. Pabco-Childers.
 - c. PRP Products Inc.

2.2 INSULATION MATERIALS

- A. General Requirements: All insulation materials shall comply with the following:
- 1. Products shall not contain asbestos, lead, mercury, or mercury compounds.
 - 2. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
 - 3. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
 - 4. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- B. Glass Mineral-Fiber Board Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB, 3 PCF density, both with and without facing. Facing shall be an all-service jacket (ASJ) manufactured from kraft paper, fiberglass reinforcing scrim, and aluminum foil backing, complying with ASTM C 1136, Type I.
- 1. Board without facing shall only be used with a field-applied jacket.
 - 2. Water vapor permeance for facing shall be 0.02 perms, maximum, as per ASTM E96- Procedure A.
- C. Glass Mineral-Fiber Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 1393, Type IIIB, Category 2, 2-1/2 PCF density, both with and without facing. Facing shall be an all-service jacket (ASJ) manufactured from kraft paper, fiberglass reinforcing scrim, and aluminum foil backing, complying with ASTM C 1136, Type I.
- 1. Blanket without facing shall only be used with a field-applied jacket.
 - 2. Water vapor permeance shall be 0.02 perms, maximum, as per ASTM E96- Procedure A.
- D. Flexible Elastomeric Thermal Insulation: EPDM-based, closed-cell, flexible elastomeric insulation. NBR/PVC based materials are not acceptable. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials. 25/50 flame spread and smoke developed rating in accordance with ASTM E84. The material shall be rated for continuous service temperatures as high as 250 deg. F.
- 1. Water Vapor Permeance: 0.08 perms, maximum, as per ASTM E96 - Procedure A (dry cup).
 - 2. Adhesive: As recommended by insulation material manufacturer.
 - 3. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.

4. Materials shall have a maximum thermal conductivity of 0.265 Btu-in./h-ft²- °F at a 75°F mean temperature when tested in accordance with ASTM C 177 or ASTM C 518, latest revisions.

2.3 JACKET TAPES

- A. All-Service Jacket (ASJ) Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Width: 3 inches.
 2. Thickness: 11.5 mils.
 3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.4 FIELD-APPLIED JACKETS

- A. General: ASTM C 921, Type 1, unless otherwise indicated as not requiring a vapor retarder.
- B. Aluminum Jacket: Deep corrugated sheets manufactured from aluminum alloy complying with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14, and having an integrally bonded moisture barrier over entire surface in contact with insulation.
 1. Finish: Smooth or stucco-embossed finish, 0.016 inch thick.
 2. Moisture Barrier: 1-mil-thick, heat-bonded polyethylene and kraft paper.

2.5 ACCESSORIES AND ATTACHMENTS

- A. Bands: 3/4-inch-wide, in one of the following materials compatible with jacket:
 1. Stainless Steel: ASTM A 167 or ASTM A 240, Type 304; 0.015 inch thick.
 2. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick.
- B. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.
- C. Weld-Attached Anchor Pins and Washers: Copper-coated steel pin for capacitor-discharge welding and galvanized speed washer. Pin length sufficient for insulation thickness indicated.
 1. Welded Pin Holding Capacity: 100 lb for direct pull perpendicular to the attached surface.
- D. Adhesive-Attached Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.

1. Adhesive: Recommended by the anchor pin manufacturer as appropriate for surface temperatures of ducts, plenums, and breechings; and to achieve a holding capacity of 100 lb for direct pull perpendicular to the adhered surface.
- E. Self-Adhesive Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.
- F. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

2.6 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

2.7 CORNER ANGLES

- A. Aluminum Corner Angles: 0.040-inch-thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of equipment.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each equipment system.

- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either the wet or dry state.
- D. Apply multiple layers of insulation with longitudinal and end seams staggered.
- E. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- F. Keep insulation materials dry during application and finishing.
- G. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- H. Apply insulation with the least number of joints practical.
- I. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
- J. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.
- K. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.
- M. Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.
- N. Install vapor-retarder mastic on equipment scheduled to receive vapor retarders. Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.
- O. Insulate equipment scheduled to receive insulation in this Section or as indicated on the Drawings.

P. Omit insulation from the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Hand holes.
6. Cleanouts.
7. Equipment provided with factory insulation and jacketing meeting the requirements of the relevant Division 23 Section.
8. Do not insulate the portion of equipment, valves, etc. for which the manufacturer has specifically recommended against insulating.

3.4 INDOOR EQUIPMENT, TANK AND VESSEL INSULATION APPLICATION

A. Fiberglass Blankets, Board, and Block Applications for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to the equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joint. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesive-attached or self-adhesive anchor pins and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. On tank and vessel, 3 inches' maximum from insulation end joints, and 16 inches o.c. in both directions.
 - c. Do not over-compress insulation during installation.
 - d. Cut and miter insulation segments to fit curved sides and dome heads of tanks and vessels.
5. Impale insulation over anchor pins and attach speed washers.
6. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing
7. Secure each layer of insulation with stainless-steel bands.
8. Stagger joints between insulation layers at least 3 inches.
9. Apply insulation in removable segments on equipment access doors and other elements that require frequent removal for service.
10. Bevel and seal insulation ends around manholes, hand holes, ASME stamps, and nameplates.
11. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

3.5 FIELD-APPLIED JACKET APPLICATION

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturers recommended adhesive.
 - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- B. Where aluminum jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.
- C. Where jacketing tapes are indicated, comply with the following:
 - 1. Apply jacketing tape in accordance with manufacturer's instructions. Do not use the tape as a substitute for banding or other means of securely attaching insulation and underlying materials. Apply tape to clean, dry, smooth-faced insulation with a factory FSK or ASJ type jacket.
 - 2. The contractor shall verify and obtain the latest installation instructions from the jacketing tape manufacturer prior to any work being done.
 - 3. Apply the tape in accordance with manufacturer's air, material, and surface temperature requirements. Apply firm, uniform pressure with hand roller to entire membrane to ensure proper adhesion. Concentrate pressure at seams.
 - 4. Apply minimum 4-inches butt laps and minimum 6-inches circumferential laps.
 - 5. Lay out tees, elbows, and valves using standard fitting two-piece methods, modified to allow for overlap seals. Add 1-1/2 inches (38.1-mm) to 2-inches (50.8-mm) to the bottom half of the fitting. Add 1-1/2 inches (38.1-mm) to the top half of the fitting. The bottom piece is installed first, and then the top piece lapped over the bottom piece to permit water shedding over the lap. Tees, elbows, valves, and other fittings can be fabricated using standard layout procedures, adding 1-1/2 inches (38.1-mm) to 2-inches (50.8-mm) for the required laps. Fittings may also be gored. Oversize each gore piece to allow for a lap onto the preceding piece. All fittings shall be vapor sealed to the jacketing tapes.

3.6 FINISHES

- A. Paint insulation and jackets as specified in Division 09 Section "Painting."
 - 1. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.7 PIPELINE APPURTENANCE INSULATION SCHEDULE

- A. Heating Hot Water System: Strainers, Check Valves, Automatic Temperature Control Valves, Pump Suction Diffusers, and Triple Duty Valves / Flow Control Valves / Balancing Valves / Balancing Cocks.
 - 1. Insulation Material: Custom Fitted Removable Thermal Insulation Blankets.

2. Insulation Thickness: 1-1/2-inches.
- B. Heating Hot Water Systems: Shut off valves (e.g. ball, gate, butterfly, etc.), unions, temperature control valves, strainers, check valves, and similar pipeline appurtenances not specified above to have Custom Fitted Removable Thermal Insulation Blankets shall be insulated and jacketed as per the connecting piping as per Division 23 Section 230719.
1. Exception: Control valves and unions may be left uninsulated on heating hot water systems.
- C. All Piping Systems: Insulate and jacket shut off valves (e.g. ball, gate, butterfly, etc.), unions, temperature control valves, strainers, check valves, and similar pipeline appurtenances as per the connecting piping as per Division 23 Section 230719.
1. Exception: Control valves and unions may be left uninsulated on heating hot water systems.
- D. Provide labels on piping jacketing at check valves, unions, and other obscured appurtenances so their locations can be identified afterwards.
- 3.8 INTERIOR TANK, EQUIPMENT, AND VESSEL INSULATION SCHEDULE
- A. Heating hot-water air separators, one shot chemical feeder vessels , expansion tanks, and buffer tanks (if not factory insulated and jacketed).
1. Insulation Material: Glass mineral fiber board with ASJ, back-scored to conform to equipment profiles.
 2. Insulation Thickness: 2-inches.
 3. Field-Applied Jacket: Aluminum.
 4. Vapor Retarder Required: No.
 5. Vapor Retarder Required: Yes.

END OF SECTION

SECTION 230719

HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.
- B. Related Sections include the following:
 - 1. Division 23 Section "Hangers and Supports for HVAC Piping and Equipment" for requirements related to pipe insulation shields, thermal-hanger shields and shield inserts, and protection saddles.

1.2 SUMMARY

- A. This Section includes pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

1.3 ACTION SUBMITTALS

- A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed a craft training program offered by the Contractor, insulation material manufacturer, or trade association relating to the installation of pipe insulation for commercial, industrial and institutional applications. Installers shall also have no less than one (1) year of relevant experience.
- B. Installation Standards: The application of insulation shall conform to the Midwest Insulation Contractors Association's (MICA) "National Commercial and Industrial Insulation Standards", 8th Edition, except where the content of this Section conflicts.

- C. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
 - 1. Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
- D. Minimum Insulation Thicknesses and R-Values: Conform to requirements of ASHRAE Standard 90.1- 2013 and the 2015 International Energy Conservation Code (IECC), or the requirements of this Section, whichever is most demanding.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.
- B. Protect materials from dirt and water. If insulation materials are dirtied or wetted, they shall not be installed, or shall be removed from the piping if wetted or soiled after installation.

1.7 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements for insulation application during the preparation of piping shop drawings and coordination drawings, and during piping system installation..

1.8 SCHEDULING

- A. Schedule insulation application after testing piping systems. Insulation application may begin on segments of piping that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1. Glass Mineral-Fiber Insulation:
 - a. Johns Manville Corp.
 - b. Knauf Insulation.
 - c. Manson Insulation Inc.
 - d. Owens-Corning Fiberglas Corp.

2. PVC Jackets and Fitting Covers:
 - a. Speedline.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Proto Corp.

2.2 INSULATION MATERIALS

- A. General Requirements: All insulation materials shall comply with the following:
 1. Products shall not contain asbestos, lead, mercury, or mercury compounds.
 2. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
 3. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
 4. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- B. Glass Mineral-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:
 1. Pre-formed/ Pre-Molded Pipe Insulation: Comply with ASTM C 547, Type 1, with factory-applied, all-service, vapor-retarder jacket (ASJ). Minimum 40% total (pre- and post-consumer) recycled content. Density shall be no less than 3.5 PCF, per ASTM C302.
 - a. All Service Jacket (ASJ): White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing, complying with ASTM C 1136, Type I.
 - 1) Self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip to provide a full adhesive closure system. ASJs requiring stapled closures are not acceptable.
 - 2) Water Vapor Permeance: 0.02 perms, maximum, as per ASTM E96-Procedure A (dry cup).
 - 3) Butt strips shall be fabricated of the same material, and with the same backing adhesive.
 2. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:
 - a. Class 1, Grade A for bonding glass cloth and tape to un-faced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to un-faced glass-fiber insulation.
 - b. Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.
 3. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
 4. Mineral-Fiber Insulating Cements: Comply with ASTM C 195.
 5. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

6. Water Vapor Permeance: 0.08 perms, maximum, as per ASTM E96 - Procedure A (dry cup).
 7. Adhesive: As recommended by insulation material manufacturer.
 8. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.
 9. Materials shall have a maximum thermal conductivity of 0.265 Btu-in./h-ft²- °F at a 75°F mean temperature when tested in accordance with ASTM C 177 or ASTM C 518, latest revisions.
- C. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.3 JACKET TAPES

- A. All-Service Jacket (ASJ) Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Width: 3 inches.
 2. Thickness: 11.5 mils.
 3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.4 FIELD-APPLIED JACKETS

- A. General: ASTM C 921, Type 1, unless otherwise indicated.
- B. PVC Jacket: High-impact, ultraviolet-resistant PVC; roll stock ready for shop or field cutting and forming, meeting ASTM 1784.
1. Adhesive: As recommended by insulation material manufacturer.
 2. PVC Jacket Color: White.
- C. PVC Fitting Covers: Factory-fabricated fitting covers manufactured from minimum 30-mil-thick, high-impact, ultraviolet-resistant white PVC.
1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps,, traps, and mechanical joints..
 2. Adhesive: As recommended by insulation material manufacturer.

2.5 ACCESSORIES AND ATTACHMENTS

- A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, pre-sized a minimum of 8 oz./sq. yd.
1. Tape Width: 4 inches.

- B. Bands: 3/4-inch-wide, in one of the following materials compatible with jacket:
 - 1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
 - 2. Aluminum: 0.007 inch thick.
- C. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.
- D. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

2.6 VAPOR RETARDERS

- A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.
- B. Do not apply insulation to wet surfaces.

3.3 GENERAL APPLICATION REQUIREMENTS

- A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.
- C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.
- E. Apply multiple layers of insulation with longitudinal and end seams staggered.

- F. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- G. Keep insulation materials dry during application and finishing.
- H. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- I. Apply insulation with the least number of joints practical.
- J. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.
- K. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.
 - 1. Apply insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
 - 3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.
- L. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- M. Apply adhesives and mastics at the manufacturer's recommended coverage rate.
- N. Apply insulation with factory-applied jackets as follows:
 - 1. Pull jacket tight and smooth.
 - 2. Circumferential Joints: Cover with 3-inch-wide butt strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c. For below-ambient services, apply vapor-barrier mastic over staples.
 - a. Exception: Do not use staples on insulation for which a full adhesive closure systems is specified.
 - 3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap.
 - a. Exception: Do not staple longitudinal laps on below ambient services.

4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
 5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.
- O. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
1. Seal penetrations with vapor-retarder mastic.
 2. Apply insulation for exterior applications tightly joined to interior insulation ends.
 3. Extend metal jacket of exterior insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal metal jacket to roof flashing with vapor-retarder mastic.
- P. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- Q. Below Grade Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.
- R. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.
- S. Fire-Rated Wall and Partition Penetrations: Apply insulation at penetrations of fire-rated walls, and partitions to conform to applicable UL requirements. Seal with firestop material.
- T. Floor Penetrations: Apply insulation at penetrations of floor assemblies to conform to applicable UL requirements. Seal with firestop material.
1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.
- 3.4 GLASS MINERAL-FIBER INSULATION APPLICATION
- A. Apply insulation to straight pipes and tubes as follows:
1. Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.
 2. Where vapor retarders are indicated, and for services operating below ambient conditions:
 - a. Seal longitudinal seams and end joints with vapor-retarder mastic.

- b. Apply vapor retarder to ends of insulation at intervals not exceeding 12 feet to form a vapor retarder / water dam between pipe insulation segments to prevent extended moisture migration should the vapor barrier in one segment become compromised.
 - c. Vapor / water dams shall also be at valves, flanges, elbows, tees, and similar fittings as recommended in Section 2 of NAIMA's "Guide to Insulating Chilled Water Piping Systems with Mineral Fiber Pipe Insulation", 1st Edition (2015).
 3. For insulation with factory-applied jackets, secure laps with butt strips with factory applied adhesive.
 4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.
- B. Apply insulation to flanges as follows:
 1. Apply pre-formed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 4. Apply glass cloth jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch, and seal joints with vapor-retarder mastic.
- C. Apply insulation to fittings and elbows as follows:
 1. Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When pre-molded insulation elbows and fittings are not available, apply mitered sections of pipe insulation to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.
 3. Cover fittings with fitting covers. Overlap covers on pipe insulation jackets at least 1 inch at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
 4. For large sizes or odd shapes where fitting covers are not available, use ICA Hamfab, or equivalent, custom pre-molded insulators, and finish over with glass-cloth jacket and sealing mastic.
- D. Apply insulation to valves and specialties as follows:
 1. Apply pre-molded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For strainers, arrange insulation for access to strainer basket without disturbing insulation.
 3. Apply insulation to flanges as specified for flange insulation application.
 4. Use pre-formed fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

5. For larger sizes and odd shapes where fitting covers are not available, seal insulation with use ICA Hamfab, or equivalent, custom pre-molded insulators, and finish over with glass-cloth jacket and jacket and sealing compound recommended by the insulation material manufacturer.

3.5 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets and/or fitting covers are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
 2. Jacketing shall be adhered to insulation with contact adhesive and 1-1/2" wide tape at all seams.
 3. Tightly butt sections together and seal joints with mastic to visually conceal joints. Use long sections to keep joints to a minimum. Install jacketing so that seams are concealed from view.
 4. Conform to manufacturer's installation recommendations.
- B. Where metal jackets and/or fitting covers are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.6 FIELD-APPLIED JACKET APPLICATION SCHEDULE

- A. Interior, Exposed: Apply full PVC jacket and fitting covers for all insulated interior piping exposed to view in finished areas of the building, in mechanical rooms for portions of the piping system within 7 feet of the floor, and elsewhere the piping is exposed and subject to abuse. Apply PVC fitting covers to all exposed, interior insulated piping.
- B. Interior, Concealed: Apply PVC fitting covers to all concealed, interior insulated piping.

3.7 FINISHES

- A. Paint insulation and jacket as specified in Division 09 Section "Painting."
 1. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.8 PIPING SYSTEM APPLICATIONS

- A. Insulation materials and thicknesses are specified in schedules at the end of this Section.

- B. Items Not Insulated: Unless otherwise indicated, do not field-apply insulation to the following systems, materials, and equipment:
 - 1. Flexible connectors on heating hot water systems.
 - 2. Vibration-control devices.
 - 3. Unions, except on piping exposed in finished spaces, and on services operating below ambient temperature. Where unions are insulated, provide a label on the piping jacket identifying the union's location.
 - 4. Automatic temperature control valves, size 1" and smaller, on heating hot water systems.
 - 5. Backflow preventers.
 - 6. Do not insulate the portion of valves and other pipeline appurtenances that the manufacturer has specifically recommended against insulating.
 - 7. Specialty valves receiving factory insulation kits as specified in Division 23 Section "Hydronic Piping".
- C. Insulate fittings and flanges as per the connecting piping.
- D. Insulate and jacket shut off valves (e.g. ball, gate, butterfly, etc.), unions, temperature control valves, strainers, check valves, and similar pipeline appurtenances as per the connecting piping.
 - 1. Exceptions: As noted above, and where those items are specified to have custom fitted removable thermal insulation blankets in Division 23 Section "HVAC Equipment Insulation".
- E. Provide labels on piping jacketing at check valves and unions so their locations can be identified afterwards.

3.9 INTERIOR INSULATION APPLICATION SCHEDULE

- A. This application schedule is for aboveground insulation inside the building.
- B. Refer to the "Field-Applied Jacket Application Schedule" article herein for field applied insulation jackets.
- C. Where a vapor retarder is indicated below, provide a fully vapor sealed installation with no voids.
- D. Service: Heating hot-water supply and return piping.
 - 1. Insulation Material: Glass mineral fiber with ASJ.
 - 2. Insulation Thickness: Apply the following insulation thicknesses:
 - a. Pipe, 1-1/2 inches' diameter and smaller: 1-1/2 inches.
 - b. Pipe, 2 inches' diameter and larger: 2 inches.
 - 3. Vapor Retarder Required: No.

- E. Service: Personnel burn prevention on all piping systems.
 - 1. If a piping system or section of piping integral to a piece of equipment operates with fluid temperatures of 120 deg. F. or higher, is subject to exposure to building occupants or maintenance personnel, and is not identified to receive insulation in the above paragraphs, provide insulation and jacketing on such systems as specified above for heating hot water piping.

END OF SECTION

SECTION 230993

SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes control sequences for HVAC systems, subsystems, and equipment.
- B. Refer to the Drawings for locations of some control devices, and for quantities of equipment and systems.

1.3 GENERAL SEQUENCE OF OPERATION REQUIREMENTS

- A. Scope: The contractor provide all control components, whether they are explicitly identified or not, as required to meet the sequence of operation. For example, if the sequence indicates that a valve shall modulate as required to maintain supply duct temperature setpoint, a supply duct temperature sensor or thermostat, and all other required components shall be provided even if the item is not indicated elsewhere in the drawings or the specifications.
- B. Units: All temperatures indicated in the sequences are in degrees Fahrenheit (deg. F.). Units of pressure are in inches water gauge (in. w.g.).
- C. All HVAC controls shall be programmed in order to meet all requirements articulated in ASHRAE 90.1-2013 and the 2015 International Energy Conservation Code.
- D. All HVAC equipment and systems shall be provided with proper controls to make them fully operational. If there is no sequences of control for a particular HVAC system or equipment item, the Contractor shall provide industry standard controls appropriate for that particular item as utilized in this project.

1.4 SEQUENCES OF OPERATION - EXHAUST FANS - TAGGED EF-1 THROUGH EF-6

- A. The fan shall be energized whenever any of the following occurs:
 - 1. The space thermostat indicates a temperature above setpoint.
 - 2. The space humidistat indicates a space RH above setpoint.
 - 3. The occupancy sensor (furnished by the .4 contractor) indicates the space is occupied.

- B. The fan shall be de-energized if the reverse occurs. Refer to the detail on drawing M-10 for additional information.

1.5 SEQUENCES OF OPERATION - HEATING HOT WATER SYSTEM FOR LOOP C
(TYPICAL FOR HEATING HOT WATER SYSTEM FOR OGTC)

- A. The heating hot water system consists of a boiler and a circulating pump. The heating hot water system shall be controlled by a boiler controller furnished by the boiler manufacturer as specified in Section 235217.11. The heating hot water system serves the radiant floor system, as well as unit heaters and duct heaters.
- B. Whenever the boiler is called to fire, as determined by the outside air temperature (being at or below 55 degrees F), the controller shall start the heating hot water pump and then start the boiler. The boiler shall fire as required to maintain supply water temperature of 120 degrees F.
- C. Whenever the boiler is de-energized, the heating hot water pump shall de-energize.
- D. The heating hot water system shall interface with the radiant floor heating controller. If the radiant floor heating controller indicates an unsafe condition with respect to slab temperature or hot water piping loop temperature, the heating hot water system (pump and boiler) shall be de-energized. Coordinate controls with the boiler manufacturer (as specified under Section 235217.11) and the radiant floor system manufacturer (as specified under section 238316).

1.6 SEQUENCES OF OPERATION - RADIANT FLOOR SYSTEM

- A. Controls for this system shall be provided by the radiant floor system manufacturer as specified under Section 238316.
- B. Each of the radiant floor manifolds shall be provided with a three-way valve. The three-way valve shall modulate opened and closed as required to maintain slab temperature setpoint. Slab temperature setpoint shall be reset in order to maintain space temperature.
- C. The heating hot water system shall interface with the radiant floor heating controller. If the radiant floor heating controller indicates an unsafe condition with respect to slab temperature or hot water piping loop temperature, the heating hot water system (pump and boiler) shall be de-energized.
- D. The controls shall also not allow the hot water temperature to exceed temperature limits within the tubing itself to be at or above 130 degrees F. This shall be a separate temperature sensor than that provided with the heating hot water system controls. If this temperature meets or exceeds 130 degrees F, the controller shall send a signal to the boiler controller to de-energize. Coordinate controls with the boiler manufacturer (as specified under Section 235217.11) and the radiant floor system manufacturer (as specified under section 238316).
- E. The controls shall also not allow the slab temperature to exceed a temperature limit of 90 degrees F. If this temperature meets or exceeds 90 degrees F, the controller shall send a signal to the boiler controller to de-energize.

- F. Refer to Section 238316 for additional control requirements associated with the radiant floor system.

1.7 SEQUENCES OF OPERATION - ENERGY RECOVERY VENTILATOR - ERV-1, ERV-2, ERV-3

- A. The ERV shall be energized upon any of the following occurrences:
 - 1. The space thermostat indicates a temperature above setpoint.
 - 2. The space humidistat indicates a space RH above setpoint.
 - 3. The occupancy sensor (furnished by the .4 contractor) indicates the space is occupied.
- B. Whenever the unit is started, the associated OA intake isolation damper and the associated exhaust air damper shall open fully. Whenever the units are de-energized, the dampers shall close.
- C. The unit shall be provided with frost control. Whenever frost protection is activated, the unit supply fan shall be de-energized, the unit exhaust fan shall remain energized, and the dampers shall remain open for a five minute period of time. Coordinate with unit controls as specified in Section 237200.
- D. The unit shall be provided with economizer control. Whenever the outside air, measured from an outdoor air thermostat, exceeds 65 degrees F, the outdoor air bypass damper shall open. Upon a drop in outdoor air temperature below 65 degrees, the energy recovery ventilator shall resume normal operation.
- E. The unit is provided with low temperature lock-out. Whenever the unit low temperature lock out is active, the unit shall be de-energized.

1.8 SEQUENCES OF OPERATION - HORIZONTAL HYDRONIC UNIT HEATER - TAGGED HUH-X

- A. Temperature: A space thermostat shall start the unit's fan to maintain its setpoint. The fan shall start only if a pipe mounted aquastat senses hot water.

1.9 SEQUENCES OF OPERATION - DUCT HEATING COIL - TAGGED DHC-1, DHC-2, DHC-3

- A. The controls for the duct heating coils shall only be enabled whenever the associated ERV is energized.
- B. Whenever the controls for the duct heating coil is disabled, the three-way control valve shall be fully open to bypass.
- C. Whenever the controls for the duct heating coil is enabled, the three-way control valve shall be modulated as required in order to maintain a supply air setpoint of 68 degrees F. As supply air temperature drops below setpoint, the three-way valve shall be opened up toward the coil. As the supply air temperature rises above setpoint, the three-way valve shall open toward the bypass.

1.10 SEQUENCES OF OPERATION - ELECTRIC WALL HEATER - TAGGED EWH-X

- A. Controls shall be by unit manufacturer as specified in Section 238249.
- B. Heater shall be provided with a built-in adjustable thermostat.
- C. Heater elements shall cycle on and off as required to maintain space temperature whenever the heater fan is indexed on.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 232113
HYDRONIC PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

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

- B. Related Division 23 Sections include the following:
 - 1. Division 23 Section "Common Work Results for HVAC" for general piping materials and installation requirements, and for flexible piping connectors.
 - 2. Division 23 Section "Hangers and Supports for HVAC Piping and Equipment" for pipe supports, product descriptions, and installation requirements. Hanger and support spacing is specified in this Section.
 - 3. Division 23 Section "General-Duty Valves for HVAC Piping" for general-duty valves.
 - 4. Division 23 Section "Meters and Gages for HVAC Piping" for pressure/ temperature ports, thermometers, and pressure gages.
 - 5. Division 23 Section "Identification for HVAC" for labeling and identifying hydronic piping.
 - 6. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.
 - 7. Division 23 Section "Water Treatment for Closed Loop Systems" for cleaning and chemical treatment requirements, as well as treatment chemicals and equipment (e.g. pot feeders, bypass filters, coupon racks, etc.).
 - 8. Division 23 Section "Radiant Floor Hydronic Tubing" for hydronic tubing for radiant floor applications.

1.2 SUMMARY

- A. This Section includes piping and fittings, special-duty valves, and hydronic specialties for hot-water heating, and other circulating HVAC piping systems; makeup water for these systems; and blowdown drain lines.

1.3 ACTION SUBMITTALS

- A. Product Data: Product Data including rated capacities where applicable, including piping, fittings, furnished options and accessories, and installation instructions for each specialty indicated. Include flow and pressure drop curves based on manufacturer's testing for balancing cocks and flow-control devices.

- B. Piping Shop Drawings: Detail fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops. Also include control valves, low measuring stations, temperature and pressure sensors, and all other control devices required.

1.4 INFORMATIONAL SUBMITTALS

- A. Delegated-Design Submittal:
 - 1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
 - 2. Locations of pipe anchors and alignment guides and expansion joints and loops.
 - 3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
 - 4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.
- B. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Other building services.
 - 3. Structural members.
 - 4. Other items required to be included as per the provisions of Division 23 Section "Common Work Results for HVAC".
- C. Welding Certificates: Copies of certificates for welding procedures and personnel.
- D. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Failed test results and corrective action taken to achieve requirements.
- E. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For hydronic specialties and special-duty valves to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

- B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
 - 1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators, buffer tanks, and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

1.7 SYSTEM PRESSURE AND TEMPERATURE RATINGS

- A. All components of the heating hot water system shall be suitable for a minimum continuous 125 psig working pressure at 220 deg F, and higher where indicated or specified.
- B. All components of the following miscellaneous systems shall have the indicated temperature and pressure ratings:
 - 1. Blowdown and Drain Piping: 220 deg F .
 - 2. Air-Vent Piping: 200 deg F .
 - 3. Relief-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.
 - 4. Makeup-Water Piping: 125 psig at 100 deg F

1.8 COORDINATION

- A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate pipe fitting pressure classes with products specified in related Sections.
- C. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 23 Section "Common Work Results for HVAC".
- D. Coordinate installation of pipe sleeves for penetrations through walls and floor assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1. Pressure-Seal Fittings and Couplings for Copper Tube:
 - a. Apollo Valve
 - b. Nibco Inc.
 - c. Viega LLC

2. Flow Control Devices / Flow Control Valves (i.e. Manual Calibrated Balancing Valves):
 - a. Anvil International
 - b. Armstrong Fluid Technology
 - c. Flow Design, Inc.(FDI); a Div. of IMI

 - a. Griswold Controls LLC
 - b. HCI, Inc.
 - c. Bell and Gossett, a Div. of Xylem Inc.
 - d. Nibco Inc.
 - e. TA Hydronics/ IMI Hydronic Engineering
 - f. Taco, Inc.

3. Combination Valve Kits:
 - a. Belimo
 - b. Flow Design Inc. (FDI); a Div. of IMI
 - c. Griswold Controls LLC
 - d. HCI Inc.
 - e. Nexus
 - f. TA-IMI / Victaulic Co.
 - g. Bell and Gossett, a Div. of Xylem Inc.

4. Globe Type Silent Check Valves at Pumps:
 - a. Metraflex Company
 - b. Mueller Steam Specialty
 - c. Keckley Co.
 - d. Titan Flow Control, Inc.

5. Pressure Relief Valves:
 - a. Amtrol, Inc.
 - b. Armstrong Fluid Technology
 - c. Conbraco Industries, Inc.
 - d. Xylem/McDonnell & Miller.
 - e. Keckley Co.

6. Expansion Tanks:
 - a. Amtrol, Inc.
 - b. Armstrong Fluid Technology
 - c. Bell and Gossett, a Div. of Xylem Inc.
 - d. Grunfos Pumps Corp.
 - e. Taco, Inc.
 - f. Wessels Co.

7. Coalescing Media Type Air Separators, Connection Size Smaller Than 2-inch NPS:
 - a. Bell and Gossett, a Div. of Xylem Inc. ('EAS' or 'EASB-JR' series)
 - b. Taco Inc. ('4900' series)

- c. Spirotherm ('Junior' series)
8. Y-Pattern Strainers:
- a. Armstrong International Inc.
 - b. Bell and Gossett, a Div. of Xylem Inc.
 - c. Eaton / Hayward
 - d. Flexicraft Industries
 - e. Metraflex Co.
 - f. Mueller Steam Specialty
 - g. Nibco
 - h. Keckley Co.
 - i. Spirax Sarco
 - j. IMI-TA
 - k. Watts
9. Buffer Tanks:
- a. Amtrol
 - b. AO Smith
 - c. Cemline
 - d. John Wood Co. Inc.
 - e. Lochinvar
 - f. Niles Steel Tank; a Div. of Bradford White Corp.
 - g. Taco Inc.
 - h. Wessels Co.

2.2 PIPE AND TUBING MATERIALS

- A. General: Refer to Part 3 "Pipe Applications" Article for identifying where the following materials are used.
- B. Drawn-Temper Copper Tubing: ASTM B 88, Type L. Only piping manufactured in the USA or Canada is acceptable.

2.3 FITTINGS

- A. General: Refer to Part 3 "Pipe Applications" Article for identifying where the following materials are used.
- B. Wrought-Copper Fittings (for Hydronic / Pressure services): ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.

2.4 JOINING MATERIALS

- A. Welding Materials: Comply with Section II, Part C of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

- B. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.
- C. Solder Filler Metals: ASTM B 32, Alloy Sb5, 95-5 tin antimony.
- D. Flux: ASTM B 813, non-self-cleaning type.

2.5 VALVES

- A. Check, ball, and butterfly valves are specified in Division 23 Section "General-Duty Valves for HVAC Piping."
- B. Refer to Part 3 "Valve Applications" Article of this Section for specific uses and applications for each valve specified.
- C. Flow Control Devices / Flow Control Valves (i.e. Manual Calibrated Balancing Valves): 125-psig working pressure, 230 deg F maximum operating temperature, y-pattern globe or ball valve with calibrated orifice. Provide with connections for portable differential pressure meter with integral check valves and seals. Valve shall have integral pointer and calibrated scale to register degree of valve opening and memory stop to retain set position. Valves 2-inch NPS and smaller shall have bronze body with threaded ends.
 - 1. Provide a flow control device where "balancing cocks", sized 2" and smaller, are indicated on the Drawings.
 - 2. Provide flow control devices where "flow control valve" is indicated on the Drawings.
 - 3. For flow control devices sized up to 6", provide a factory insulation kit. The kit shall consist of a polyurethane foam insulation with a plastic coated exterior surface and molded to fit the valve contours. The insulation shall be split into two interlocking pieces, held together with reusable nylon bands or straps. The insulation shall be easily removable and reinstalled. The foam shall be a minimum of 1" thick and suitable for valve body temperatures up to 230 deg F.
- D. Combination Valve Kits: For hydronic branch piping to equipment sized at 1" and smaller, the Contractor, at his option, in lieu of the separate valves/ appurtenances shown on the drawings, may provide a valve combination package incorporating flexible hoses, a manual calibrated balancing valve, a temperature control valve, pressure-temperature (P/T) ports, a strainer, unions, manual air vent, drain valve, a pair of isolation ball valves, and any other devices detailed on the Drawings. More than one function may be combined into a single device/appurtenance, however the full scope and arrangement of functions shall match that detailed on the drawings, at the minimum. Each kit shall be "bagged and tagged" for easy identification and storage. The entire kit shall be suitable for no less than 150-psig working pressure at 225 deg F.
 - 1. Shut-off ball valves shall be as specified in Division 23 section "General-Duty Valves for HVAC Piping".
 - 2. P/T ports shall be 1/4" size, have a self-sealing core, brass body, and a gasketed and threaded cap, with retention chain or strap.
 - 3. Manual air vents shall have a bronze body and nonferrous internal parts; manually operated with screwdriver or thumbscrew; with 1/8-inch NPS discharge connection.

4. Strainers shall be on the supply side of the unit and shall be bronze body with threaded ends, stainless steel strainer, and ball-type drain valve with 3/4" threaded hose connection and cap. Straining element shall be 30 mesh.
 5. Manual calibrated balancing valves shall meet the requirements of the "Flow Control Devices (Manual Calibrated Balancing Valves)" paragraph herein. Provide an insulation kit.
- E. Globe Type Silent Check Valves (at Pumps), sizes smaller than 2-1/2": Provide on the discharge of pumps to control surge pressures and resulting water hammer, with a single center-guided, spring-loaded brass or stainless steel disc. Valve shall be suitable for 400 psi CWP. Valves shall be ASTM B62 bronze globe body, with bronze or stainless steel trim and threaded ends. Seat shall be resilient, replaceable, and suitable for up to 250 deg F. working temperature.
- F. Pressure Relief Valves: Brass or bronze body with brass and rubber, wetted, internal working parts; to suit system pressure and heating capacity; according to ASME Boiler and Pressure Vessel Code, Section IV.
- G. Make-up Water Pressure Reducing Valves: Provide on cold water makeup piping to the hydronic system, water pressure reducing valves to provide automatic filling of the systems. Pressure reducing valve shall be suitable for 150 psi CWP, with cast bronze body and bronze trim. Reducing valves shall be set to system fill pressure.

2.6 HYDRONIC SPECIALTIES

- A. Manual Air Vent: Bronze body and nonferrous internal parts; 150-psig working pressure, 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; with 1/8-inch NPS discharge connection and 1/2-inch NPS inlet connection.
1. Provide at all hydronic equipment connections that have piping connections sized 1" and smaller.
- B. Piping System Manual Air Vents: 3/4" ball valve with a threaded nipple (for hose connection) and cap. Valve shall comply with the provisions of Division 23 Section "General Duty Valves for HVAC Piping", except that one-piece bodies and both standard and reduced ports are acceptable (in lieu of 2-piece body and full port).
1. Provide at all high points in the piping system, both local and overall, for venting of air as part of the system fill process.
 2. Provide at all hydronic equipment connections that have piping connections sized 1-1/4" and larger.
- C. Piping System Automatic Air Vent: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig working pressure, 240 deg F operating temperature; with 1/4-inch NPS discharge with waste connector, and 1/2-inch NPS inlet connection.
1. Provide at inaccessible high points in the piping system. Extend discharge with a copper tube matching the discharge size to an indirect waste receptor. Provide an isolation valve near the termination point, and label the valve's function.

- D. Flexible Piping Hoses: EPDM inner core, type 304 stainless steel outer reinforcing braid, with brass double-swivel type threaded ends. Hoses shall be suitable for continuous operating pressure of 150 psig at 230 deg F., with a burst pressure rating no less than 400 psig.
- E. Diaphragm-Type Expansion Tanks: Welded carbon steel rated for 125 psig working pressure, 240 deg F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity, by a flexible diaphragm securely sealed into tank. Provide taps for pressure gage and air-charging fitting, and drain fitting. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Fabricate and test tank after taps and supports are installed, and label according to ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
 - 1. Air-Charge Fitting: Schrader valve, stainless steel with EPDM seats.
- F. Coalescing Media Type Air Separators, Connection Size Smaller Than 2-inch NPS: Brass, bronze, or cast iron body, with brass, copper, or stainless steel internal coalescing media designed to capture free air bubbles and dissolved air and direct it into a top-mounted automatic air vent. Constructed and labeled for 150-psig minimum working pressure and 240 deg. F. maximum operating temperature; threaded connections; threaded blow-down connection. Minimum 1/2-inch threaded bottom blow down connection. Provide units in sizes for full-system flow capacity.
- G. Y-Pattern Strainers: Class 125; cast-iron body (ASTM A 126, Class B), flanged ends for 2-1/2-inch NPS and larger, threaded connections for 2-inch NPS and smaller, bolted cover, perforated Type 304 stainless-steel basket, and bottom drain connection. Select screen sizes as specified below, except where otherwise indicated in the Contract Documents, or where a manufacturer's recommendation indicates a finer screening.
 - 1. Closed Loop Screening Size: Except as specifically indicated otherwise on the Drawings, provide the following:
 - a. Up to 2": 20 mesh.

2.7 IN-LINE BUFFER TANKS

- A. Tanks shall be ASME Code constructed and stamped in accordance with Section VIII of the ASME Code. Tanks shall be registered with the National Board of Boiler and Pressure Vessel Inspectors and a certificate of shop inspection shall be furnished. ASME working pressure shall be 125 psi at 400 deg F. Material of construction shall be carbon steel.
 - 1. Insulation: Minimum 1.5" thick factory applied flexible elastomeric (on cold systems) or mineral fiber (hot systems) thermal insulation with painted aluminum or stainless steel jacket. Tanks used on chilled water systems shall be fully vapor sealed.
 - a. Field applied insulation and jacket is also acceptable.
 - 2. Tappings / Connections: Provide no less than the following:
 - a. Tanks shall have flanged inlet and outlet openings sized equal to the connecting piping indicated on the Drawings.
 - b. 3/4" top vent connection

- c. 3/4" or 1" bottom drain connection.
 - d. Two (2) thermowells for thermometer and temperature sensor installation, positioned to sense average tank temperature.
 - e. Plug any additional, unused taps or wells.
3. Short-Circuit Prevention: Tank shall include an internal baffle to divert water and prevent short-circuiting of flow directly between the inlet without flowing through the full volume of the tank.

PART 3 - EXECUTION

3.1 PIPE APPLICATIONS

- A. Hot Water, and other closed loop hydronic system piping , 2-Inch NPS and Smaller: Use Type L drawn-temper copper tubing with soldered joints.
- B. Blowdown Piping and Hydronic System Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown or miscellaneous drain is installed.
- C. Pressure Relief Valve Inlet and Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.2 VALVE APPLICATIONS

- A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:
 - 1. Shutoff Duty: Use ball and butterfly valves.
 - 2. Throttling Duty: Use flow control devices (i.e. calibrated balancing valves) and balancing cocks.
- B. Sizes: The size of valves and other pipeline appurtenances shall match the size of the pipe in which the valve or pipeline appurtenance is installed, unless otherwise indicated.
- C. Install shutoff-duty valves at each branch connection to supply and return mains, at supply and return connections to each piece of equipment, and elsewhere as indicated.
- D. Install flow control devices and balancing cocks on the outlet of each hydronic coil, circulating pump and elsewhere as required or shown to facilitate system balancing.
- E. Install drain valves at low points in mains, risers, branch lines, and elsewhere as shown or required for system drainage.
- F. Install spring loaded check valves on each pump discharge and elsewhere as shown or required to control flow direction.
- G. Install pressure relief valves on hot water heat exchangers, at expansion tanks, and elsewhere shown on the Drawings or as required by the ASME Boiler and Pressure Vessel Code or the PA Dept. of Labor and Industry, Boiler Division. Pipe discharge to floor without valves. Comply

with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.

3.3 PIPING INSTALLATIONS

- A. Install piping according to Division 23 Section "Common Work Results for HVAC".
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping free of sags and bends.
- F. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- G. Install air vents at all high points, both localized and overall, in the piping system consisting of a tee fitting, air collection chamber, 3/4-inch NPS ball valve, and short 3/4-inch NPS threaded nipple and cap. The quantity and locations of air vents shall be sufficient to completely purge the system of air.
- H. Install drains at low points in the piping system consisting of a tee fitting, 3/4-inch NPS ball valve, and short 3/4-inch NPS threaded nipple and cap. The quantity and locations of drains shall be sufficient to completely drain down the system.
- I. Install piping at a uniform grade of 0.2 percent downward towards drainage points / upwards towards air vents.
- J. Reduce pipe sizes using eccentric reducer fitting installed with level side up. Lap joint stub ends are not permitted.
- K. Install unions in pipes 2-inch NPS and smaller, adjacent to each valve, at final connections of each piece of equipment, and elsewhere as indicated.
- L. Install flexible connectors at inlet and discharge connections to pumps (except in-line pumps with motor sizes smaller than 3HP) and other vibration-producing equipment. Refer to Division 23 Section "Common Work Results for HVAC Equipment" for flexible piping connectors.
- M. Install strainers on inlet side of each control valve, pump, and elsewhere as indicated. Install a 3/4-inch NPS nipple and cap with a full port ball valve in blow-down connection of strainers sized 1-1/2-inch NPS and larger. The blow down size shall match the size of strainer blowoff connection where strainers have blowoff connections larger than 3/4-inch NPS.

1. Locate and orient the strainer so that gravity will assist in retaining the entrapped solids in the screening element (or "leg") or basket so solids can be properly collected and held for disposal.
 - a. Install Y-strainers in vertical downflow lines, and in horizontal lines with the screening leg located on the underside of the strainer body. Do not install in upflow orientations.
- N. Swing Connections: Branch piping connections to mains shall be made with swing connections.
1. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.
 2. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.
 3. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.
- O. Label piping as specified in Division 23 Section "Identification for HVAC."
- P. 'T-drill' and similar piping system tee forming techniques are not permitted. Use tee fittings.

3.4 HANGERS AND SUPPORTS

- A. General: Hangers, supports, and related work are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Conform to requirements below for maximum spacing of supports.
- B. Comply with requirements in Division 23 Section "Vibration Controls for HVAC" for spring hangers.
- C. Install the following pipe attachments unless otherwise indicated, or required to meet the requirements in Division 23 Section "Vibration Controls for HVAC":
1. Adjustable clevis hangers for individually supported, straight horizontal piping sections less than 20 feet long between horizontal offsets or rises.
 2. Adjustable roller hangers or spring hangers for individually supported, straight horizontal piping sections 20 feet or longer between horizontal offsets or rises.
 3. Pipe Roller: ANSI / MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 4. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- D. Install hangers for drawn-temper copper tubing with the following maximum spacing and minimum rod sizes, or in accordance with ANSI / MSS-SP-58, whichever is more demanding. (Note: Rod sizes indicated are for single pipe / single rod hangers):
1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 3/8 inch.
 2. NPS 1: Maximum span, 6 feet; minimum rod size, 3/8 inch.
 3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.

4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 5. Spacing listed above does not apply where valves or other appurtenances create concentrated loads between supports, or where there are changes in direction. Provide additional supports for these conditions.
- E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.
 - F. Provide additional hangers within 12" of each change of direction of piping, and at concentrated equipment loads.

3.5 PIPE JOINT CONSTRUCTION

- A. Refer to Division 23 Section "Common Work Results for HVAC" for joint construction requirements for soldered joints in copper tubing; threaded, welded, and flanged joints in steel piping.

3.6 HYDRONIC SPECIALTIES INSTALLATION

- A. Sizes: The size of hydronic specialties that convey the full flow of the connecting piping (e.g. strainer) shall match the size of the pipe in which the hydronic specialty is installed, unless otherwise indicated.
- B. Provide manual air vents at both local and overall high points in system, at heat-transfer coils, and elsewhere as indicated or required for system air venting.
- C. Provide dielectric fittings where required by Division 23 Section "Common Work Results for HVAC."
- D. Provide automatic air vents at air separator, and at inaccessible local high points in the system, and elsewhere as indicated. Route the discharge of inaccessible auto air vents to an approved indirect waste.
- E. Provide air separators in pump suction lines. Run piping to expansion tank with a 2 percent upward slope toward tank. Install drain valve on units 2-inch NPS and larger.
- F. Provide expansion tanks as indicated. Vent and purge air from hydronic system, and charge tank with proper air charge to match the system fill pressure or otherwise suit system design requirements. Isolation valves on the piping connecting the expansion tank to the system shall be fitted with a lockshield (so the valve may be locked open).

3.7 EQUIPMENT CONNECTIONS

- A. Piping size for supply and return connections to equipment shall be as indicated on the Drawings, or the same size as equipment connections, whichever is larger.
- B. Install control valves in accessible locations close to equipment.

3.8 HYDROSTATIC PRESSURE TESTING

- A. Hydrostatically test new piping and existing piping systems altered by the Project. The Contractor shall perform pressure tests. Advise the Client Agency and Architect/Engineer no less than 7 days in advance of testing.
1. Hydrostatic testing shall occur either immediately before flushing, cleaning/passivation, and chemical treatment of the system, or after such work has been completed. The hydronic systems shall not be left idle, filled with untreated water, for a length of time longer than necessary to perform testing. Should flash rusting of the system occur, the Contractor is responsible for whatever corrective measures are deemed necessary by the Architect / Engineer.
 2. Test prior to installing insulation.
- B. Testing Preparation: Prepare hydronic piping according to ASME B31.9 and as follows:
1. Leave joints, including welds, uninsulated and exposed for examination during test.
 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 3. Flush system with clean water. Clean strainers.
 4. Isolate equipment so that it is not subjected to test pressure from piping using valves or blinds in flanged joints. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Flanged joints where blinds are inserted to isolate equipment need not be tested.
 5. Install relief valve set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- C. Testing: Test hydronic piping as follows:
1. Use ambient temperature water as testing medium, except where there is risk of damage due to freezing. Another liquid may be used if it is safe for workers and compatible with piping system components.
 2. Use vents installed at the high points of system to release trapped air while filling system. Use drains installed at low points for complete removal of liquid.
 3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low-pressure filling lines are disconnected.
 4. Isolate expansion tanks and determine that hydronic system is full of water.
 5. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure, and not less than 100 psig, whichever is greater, however the test pressure shall not exceed maximum pressure for any vessel, heat exchanger, boiler, pump, valve, or other component in system under test. Check to verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, Code for Pressure Piping, "Building Services Piping."
 6. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components with new materials as appropriate. Leak-sealing compounds and preening are not permitted.
 7. Repeat hydrostatic test until there are no leaks.
 8. Prepare written report of testing.

- D. Use of pressurized air for testing of hydronic piping systems is strictly prohibited.

3.9 FLUSHING, CLEANING, AND CHEMICAL TREATMENT

- A. General: All hydronic systems require flushing, cleaning, and passivation. Refer to Division 23 Section "Water Treatment for Closed Loop Systems" for chemical treatment requirements, as well as treatment chemicals and equipment, and for additional system cleaning requirements.
- B. Supervision and Responsibilities: The water treatment service provider performing the work of Division 23 Section "Water Treatment for Closed Loop Systems" shall oversee the entire flushing and cleaning process performed by the Division 23 Contractor, and perform conductivity testing, in addition to performing final chemical treatment of the system. The service provider shall provide all chemicals used throughout the process, including those used for cleaning, passivating, and final chemical treatment.
- C. Initial Flushing: Flush all hydronic piping systems with clean water. Flush the system till the water runs visibly clear and has a conductivity no more than 100 micro Siemens greater than that of the fresh water supply. Remove strainer screens before flushing. After flushing, and replace strainer screens.
 - 1. Remove the flow regulating cartridge from pressure independent control valves and automatic flow balancing valves during flushing operations. Replace cartridges after the system is demonstrated to be fully flushed.
 - 2. Do not use the system pumps to perform the initial flushing of the hydronic system. The Contractor shall furnish and install a temporary pump for this purpose, or shall utilize a clean water source in a once-through manner. All costs for temporary water and drainage connections and/or use of temporary pumps shall be included in the Contractor's bid price.
 - 3. After flushing operations are complete, the Contractor shall remove the temporary pump and/or fresh water and drainage connections and install and operate the permanent pumps. The permanent pumps may be used for cleaning, passivation, and chemical treatment process. All temporary electrical and piping connections to perform the required system flushing without the use of the permanent pump are the responsibility of the Division 23 Contractor.
 - a. Refer to Division Sections "Hydronic Pumps", and "Water Treatment for Closed-Loop Hydronic Systems" for additional requirements.
 - b. If the Contractor does not comply with the above, and exposes the permanent pumps to the flushing process, the Contractor shall replace the seals and volute gaskets in all pumps exposed to the flush water 11 months after system start-up at no additional cost to the Client Agency. Extra seals and volute gaskets shall be furnished by the Contractor for this purpose.
- D. Cleaning and Passivation:
 - 1. After the hydronic system piping, circulating pumps, equipment and water passages have been flushed till visibly clear and meets the above specified conductivity limit, the system shall be cleaned by circulating mixtures of a commercially available hydronic system cleaning and passivating agent specified in Division 23 Section "Water Treatment for

- Closed Loop Systems" and water. Replace strainer screens or flow cartridges removed earlier prior to cleaning.
2. Fill, vent and circulate system with the solution. Allow solution to reach design or operating temperatures (for heating systems). After system has been circulated for the time period specified in Division 23 Section "Water Treatment for Closed Loop Systems", system shall be drained completely and refilled with fresh rinse water and circulated to remove the cleaner, and then drained once again. The system shall be thoroughly vented of air each time the system is filled.
 3. After cleaning the piping system, but before final chemical treatment and testing and balancing, remove, clean and replace strainer screens, and drain the rinse water.
- E. Chemical Treatment: Immediately after draining the system rinse water, refill the system with pre-mixed inhibited glycol solution, and chemically treat the system as specified in Division 23 Section "Water Treatment for Closed Loop Systems".

3.10 COMMISSIONING

- A. Fill system and perform flushing, cleaning, and initial chemical treatment.
- B. Check that the system is completely full of water.
- C. Verify correct water fill pressure and corresponding air charge pressure in expansion tank. Perform these steps before operating the system:
 1. Open valves to fully open position. Close coil bypass valves.
 2. Check pump for proper direction of rotation.
 3. Set automatic fill valves for required system pressure.
 4. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or bleed air completely (manual type).
 5. Set temperature controls so all coils are calling for full flow.
 6. Check and set operating temperatures of hydronic equipment (e.g. boilers, chillers, heat exchangers, etc.) to design requirements.
 7. Lubricate motors and bearings.

END OF SECTION

SECTION 232123
HYDRONIC PUMPS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.
- B. Division 23 Section "Vibration Controls for HVAC" for spring supports and hangers.
- C. Division 23 Section "Hydronic Piping" including piping system component and equipment pressure ratings applies to this section.
- D. Division 23 Section "Common Motor Requirements for HVAC Equipment" for pump motor requirements.

1.2 SUMMARY

- A. This Section includes the following categories of hydronic pumps:
 - 1. Vertical inline pumps.

1.3 ACTION SUBMITTALS

- A. Product Data: Include certified performance curves and rated capacities; shipping, installed, and operating weights; furnished specialties; final impeller dimensions; and accessories for each type of product indicated. Indicate pump's operating point on curves.
- B. Shop Drawings: Show pump layout and connections.
 - 1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Pump start-up service reports and checklists.

1.5 CLOSEOUT SUBMITTALS

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

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer. All pumps shall be factory assembled and balanced. Shop or field-assembled 'pump kits' are not acceptable.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. UL Compliance: Comply with UL 778 for motor-operated water pumps.
- D. Terms and Definitions: As per Hydraulic Institute Standards, HI 1.1-1.2 and HI 1.3, latest editions.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- B. Store pumps in dry location.
- C. Retain protective covers for flanges and protective coatings during storage.
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- E. Comply with pump manufacturer's written rigging instructions.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Mechanical Seals: One spare mechanical seal set for each pump.
 - 2. Volute Gaskets: One spare gasket set for each pump.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1. Close-Coupled In-Line Circulators:
 - a. Armstrong Fluid Technology. "Series 4280"
 - b. Bell & Gossett; Div. of Xylem Inc. "Series "[e-60][or][e-90]"

- c. Taco Inc. "Series "1600 or 1900"
- d. Grundfos Pumps Corp. Series "TP"

2.2 GENERAL PUMP REQUIREMENTS

- A. Pump Units: Factory assembled and tested.
- B. Motors: Include built-in, thermal-overload protection and grease-lubricated ball bearings. Select each motor to be nonoverloading over full range of pump performance curve.
 - 1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- C. Energy Efficiency: Minimum efficiency complying with EISA requirements.
- D. Pump rating curves shall be the result of testing and rating in accordance with the procedures of the Hydraulic Institute.
- E. Operating Points and Pump Selections: Select and submit pumps according to the schedules on the Drawings, and the following:
 - 1. The design operating point shall be no less than 25%, and no more than 85%, of the manufacturer's maximum recommended flowrate at the selected impeller size.
 - 2. The pump shutoff head is no less than that scheduled on the Drawings (i.e. zero-flow pump head).
 - 3. The selected impeller size shall be no larger than 90% of the largest impeller size that can potentially be fitted to the selected pump volute, unless scheduled otherwise on the Drawings.
- F. Dynamic Balancing: All pumps shall be dynamically balanced and tested in the factory per the Hydraulic Institute Standard, ANSI/HI 9.6.4, latest edition. Residual imbalance shall conform to ANSI grade 6.3, unless otherwise specified.
- G. Pumps shall be provided with suction and discharge gauge tappings and plugs.
- H. Impellers shall be dynamically balanced, keyed to the shaft and secured with a suitable locking capscrew or locknut arrangement.
- I. Pumps shall be factory tested, cleaned and painted with one coat of machinery enamel before shipment.

2.3 CLOSE COUPLED IN-LINE CIRCULATORS

- A. Description: Horizontal, in-line, centrifugal, close-coupled, single-stage, bronze-fitted, radially split case design; rated for 125-psig minimum working pressure and a continuous water temperature of 225 deg F.
 - 1. Casing: Cast iron, with threaded companion flanges for piping connections, and threaded gage tappings at inlet and outlet connections.

2. Impeller: ASTM B 584, cast bronze, statically and dynamically balanced, closed, overhung, single suction, and keyed to shaft.
3. Shaft and Sleeve: Carbon steel shaft with oil-lubricated copper sleeve.
4. Seals: Mechanical type. Include carbon-steel rotating ring, stainless-steel spring, ceramic seat, and flexible bellows and EPDM or EPR (ethylene propylene rubber) gasket.
5. Pump Bearings: Oil-lubricated, bronze journal and thrust type.
6. Motor Bearings: Oil-lubricated, sleeve type.
7. Motor: ECM type, directly mounted to pump casing.

2.4 PUMP SPECIALTY FITTINGS

- A. Suction Diffuser: Angle pattern, minimum 125-psig pressure rating at 250 deg F., cast-iron or ductile-iron body and end cap, pump-inlet fitting; 16 or 20 mesh bronze or stainless steel startup strainer; removable Type 304 stainless-steel permanent strainer; integral iron or stainless-steel straightening vanes; blowdown / drain plug; adjustable factory-fabricated support foot; and pressure / temperature ports on each flange. Suction diffuser shall be provided with an exterior factory paint finish.
- B. Silent Check Valves: Refer to Division 23 Section "Hydronic Piping".

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation.
 1. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
 2. Examine foundations and bases for suitable conditions where pumps are to be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

- A. Install pumps according to manufacturer's written instructions.
 1. Install pumps according to HI 1.4, latest edition.
- B. Install pumps to provide access for periodic maintenance, including removing motors, impellers, couplings, and accessories.
- C. Support pumps and piping separately so piping is not supported by pumps or flexible connectors.
- D. Suspend in-line centrifugal pumps independent of piping using channel supports. Install pumps with motor and pump shafts oriented as recommended by the manufacturer. Hang pumps from the building structural system using continuous-thread hanger rods and spring vibration hangers of sufficient size to support pump weight.

1. Provide vibration isolation hangers as specified in Division 23 Section "Vibration Controls for HVAC."

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to pumps. Install suction and discharge pipe sizes equal to those shown on the drawings. Valves and appurtenances at the pumps shall be the same size as system piping. If transitions are required, provide transitions at the pump flanges or suction diffuser inlet flange.
- D. Pipe connections to pumps shall be made in such a manner so as not to exert any stress on pump housings.
- E. Install balancing valve, check valve and shutoff valve on the discharge side of pumps.
- F. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves. Refer to Division 23 Section "Common Work Results for HVAC".
- G. Install pressure gages on pump suction and discharge. Install at integral pressure-gage tappings where provided. Install compound type gauge on suction side.
- H. Install suction diffusers on the inlet to vertical in-line pumps installed near the floor. Provide a support foot under the suction diffuser.
- I. Install electrical connections for power, controls, and devices.
- J. Electrical power wiring and connections are specified in Division 26 Sections.
- K. Ground equipment.
 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 USE OF PERMANENTLY INSTALLED PUMPS DURING INITIAL FLUSHING OF THE HYDRONIC SYSTEM

- A. The Contractor is prohibited to use the permanently installed hydronic pumps to perform the initial flushing the hydronic system. The Contractor shall furnish and install a temporary pump for this purpose, or shall utilize a clean water source in a once-through manner. After flushing operations are complete, the Contractor shall remove the temporary pump and/or fresh water connections and install and operate the permanent pump. The permanent pump may be used for cleaning, passivation, and chemical treatment process. All temporary electrical and piping connections to perform the required system flushing without the use of the permanent pump are the responsibility of the Division 23 Contractor.

1. Refer to Division 23 Sections "Hydronic Piping", and "Water Treatment for Closed-Loop Hydronic Systems" for additional requirements.
- B. If the Contractor does not comply with the above, the Contractor shall replace the seals and volute gaskets in all pumps exposed to the flush water 11 months after system start-up at no additional cost to the Client Agency. Extra seals and volute gaskets shall be furnished by the Contractor for this purpose (i.e. do not use the spare materials required by the Article "Extra Materials" elsewhere in this Section).

3.5 FIELD QUALITY CONTROL AND STARTUP SERVICE

- A. Perform startup service.
- B. Verify that pumps are installed and connected according to the Contract Documents.
- C. Verify that electrical wiring installation complies with manufacturer's written instructions and the Contract Documents.
- D. Perform the following preventive maintenance operations and checks before starting:
1. Lubricate bearings.
 2. Remove grease-lubricated bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer's written instructions.
 3. Disconnect coupling and check motor for proper rotation that matches direction marked on pump casing.
 4. Verify that pumps are free to rotate by hand and that pumps for handling hot liquids are free to rotate with pumps hot and cold. Do not operate pumps if they are bound or drag, until cause of trouble is determined and corrected.
 5. Check suction piping connections for tightness to avoid drawing air into pumps.
 6. Clean strainers.
 7. Verify that pump controls are correct for required application.
- E. Pumps shall NOT be run dry to check rotation. Only start up pumps on a system filled with clean water.
- F. Starting procedure for pumps with shutoff power not exceeding safe motor power is as follows:
1. Prime pumps by opening suction valves and closing drains, and prepare pumps for operation. Verify that pumps are vented and completely full of water.
 2. Open warm-up valves of pumps handling hot liquids if pumps are not normally kept at operating temperature.
 3. Open circulating line valves if pumps should not be operated against dead shutoff.
 4. Start motors.
 5. Open discharge valves slowly.
 6. Check general mechanical operation of pumps and motors.
 7. Close circulating line valves once there is sufficient flow through pumps to prevent overheating.
- G. When pumps are to be started against closed check valves with discharge shutoff valves open, steps are the same, except open discharge valves before starting motors.

- H. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for detailed requirements for testing, adjusting, and balancing hydronic systems.

3.6 DEMONSTRATION

- A. Train Client Agency's maintenance personnel to adjust, operate, and maintain hydronic pumps as specified below:
 - 1. Train Client Agency's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining pumps.
 - 2. Review data in maintenance manuals.
 - 3. Schedule training with Client Agency, through Architect, with at least seven days' advance notice.

END OF SECTION

SECTION 232501

WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.
- B. The following Division 23 Sections:
 - 1. "Meters and Gauges for HVAC Piping" for closed loop make-up water meters.
 - 2. "Hydronic Piping" for additional system flushing, passivating, and cleaning requirements.
 - 3. "Stainless Steel Fire Tube Condensing Boilers" for detailed requirements for water quality specified by the boiler manufacturer. In the event of a conflict between the water quality requirements of Section 235217.11 and this Section, or between the requirements of the boiler manufacturer and this Section, this Section shall not take precedence. Comply with the water quality requirements of the boiler manufacturer.
 - a. Post signage regarding the system water quality requirements as herein specified.

1.2 SUMMARY

- A. Section includes the following water treatment materials for closed-loop hydronic systems:
 - 1. Manual chemical-feed equipment
 - 2. Glycol feeder units
 - 3. Treatment and cleaning chemicals
 - 4. Glycol
- B. Sub-Contracting Arrangement: The water treatment service provider shall be an independent company that is not financially affiliated with the Division 23 Contractor.
- C. The water treatment service provider shall oversee the entire flushing and cleaning process performed by the Division 23 Contractor, and perform conductivity testing, in addition to performing final chemical treatment of the system. The service provider shall provide all chemicals used throughout the process, including those used for cleaning, passivating, and final chemical treatment. Refer to Division 23 Section, "Hydronic Piping".

1.3 ACTION SUBMITTALS

- A. Water Treatment Service Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider. The purpose of this submittal is to establish, in a proactive manner, that the service provider proposed by the Division 23 Contractor to perform

the work of this Section and related Sections is qualified. The Contractor's failure to obtain approval for this submittal prevents the Contractor from utilizing the proposed service provider. Within 15 days of contract award / notice to proceed, the Contractor shall submit the following minimum information:

1. Information demonstrating compliance with requirements identified in the "Quality Assurance" article below in this Section.
 2. Company name, number of years in business, and any other name the company may have done business under in the last 10 years.
 3. Resumes of the staff proposed to manage and perform the work of this project.
 4. Identification of technicians directly employed by the proposed vendor, who live within 100 miles of the job site.
 5. Identification of no less than five (5) qualifying project experiences, with a description of the work performed, and a contact information for the Client Agency of those projects, for the individual responsible technician in charge for the performance of work for this Project.
- B. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for all products.
- C. Chemical Treatment Program: Outline the comprehensive chemical treatment program for the closed loop systems. Indicate the purpose, composition, and target concentration of each treatment chemical proposed. Include details and product data for all treatment chemicals, along with chemical material safety data sheets. Include a schedule of tests and treatment applications on an annual basis to achieve water quality defined in the "Performance Requirements and Scope of Services" Article herein.
- D. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.
1. Include plans, elevations, sections, and attachment details.
 2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Other Informational Submittals:
1. Boiler water treatment advisory signage text. Coordinated with boiler representative / manufacturer.
 2. Water Analysis: Illustrate water quality available at Project site.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For chemical water treatment shall be included in the operation and maintenance manual. Include detailed manufacturer's instructions and parts list for each item of equipment, control, and accessory. Include troubleshooting maintenance guide.

- B. Closeout report and maintenance plan. Refer to "Field Quality Control" article herein.

1.6 QUALITY ASSURANCE

- A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.
 - 1. Subject to requirements, the independent water treatment service provider shall be one of the following:
 - a. Barclay Water Management
 - b. Chardon Laboratories
 - c. Chem-Aqua Inc.
 - d. ChemTreat Inc.
 - e. Clarity Water Technologies LLC
 - f. Garratt-Callahan Co.
 - g. GE Power and Water
 - h. Guardian CSC
 - i. Nalco; a Div. of Ecolab
 - j. SUEZ Water Technologies & Solutions
 - k. Approved Equal
 - 2. The water treatment company shall have been in business no less than five (5) years.
 - 3. The water treatment company shall have at least one (1) officer or official holding a college or university degree in chemistry, chemical engineering or sanitary engineering and who is a licensed Professional Engineer (P.E.). This individual shall have at least ten (10) years' experience in treating the water in systems of similar size and capacity.
 - 4. The individual responsible technician in charge for the performance of work for this Project shall have not less than five (5) years' experience in treating water in systems of similar size and capacity and he shall be in active responsible charge of all treatment work.
 - a. This individual shall be on-site whenever any services are being provided by the water treatment service vendor.
 - 5. Qualifications: The water treatment company shall directly employ no less than one (1) technician qualified to service and maintain the system who lives within 100 miles of the job site.
 - 6. The company's laboratory shall be equipped to analyze samples in accordance with the standard methods of the American Water Works Association and the American Society of Testing and Materials.
- B. Chemical Standards: Meet state and local pollution-control regulations. Chemical containers shall be marked with the chemical name and appropriate hazard warnings as required by OSHA 29, CFR 1910.1200.
- C. Comply with NFPA 70 for components and installation.

- D. Electrical Components, Devices, and Accessories: Provide products specified in this Section that are listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:

1. Chemical Water Treatment Products:
 - a. Accepta
 - b. Barclay Chemical Co., Inc.
 - c. Chem-Aqua Inc.
 - d. ChemTreat Inc.
 - e. DuBois Chemicals, Inc.; DuBois USA Subsidiary
 - f. Garratt-Callahan Co.
 - g. GE Power and Water
 - h. Inter-State Chemical Co.
 - i. Nu-Calgon
 - j. Nalco
 - k. Sentinel Performance Solutions Ltd.
 - l. State Chemical Solutions, a Div. of State Industrial Products
 - m. SUEZ Water Technologies & Solutions
2. One-Shot Bypass Chemical Feeders:
 - a. Axiom Industries
 - b. GE Water and Process Technologies
 - c. Griswold Water Systems
 - d. JL Wingert
 - e. John Wood Company
 - f. Neptune / PSG Dover
 - g. Skidmore; a Div. of The Swan Group
 - h. Wessels Co.
3. Glycol Feeder Units:
 - a. Advantage Controls
 - b. Armstrong
 - c. Axiom Industries
 - d. ITT Bell and Gossett
 - e. John Wood Co.
 - f. Neptune
 - g. Skidmore; a Div. of The Swan Group
 - h. Wessels Co.

4. Inhibited Propylene Glycol:
 - a. Dow Chemical Co. (Dowfrost HD).
 - b. Dynalene (PG)
 - c. Ohio Chemical Services (Protocol NT).
 - d. Interstate Chemical (Intercool NFP).
 - e. Sentinel Performance Solutions Ltd. (Sentinel X500)

2.2 PERFORMANCE REQUIREMENTS AND SCOPE OF SERVICES

- A. The HVAC Water-Treatment Service Provider shall provide the services detailed herein.
- B. Water quality for hydronic systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.
- C. Base HVAC water treatment on quality of water available at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
 1. Obtain water samples at job site to determine required treatment. Provide report outlining water analysis with the chemical treatment program submission.
- D. The scope of services provided by the HVAC Water-Treatment Service Provider shall include, but is not limited to, the following:
 1. Provide all cleaning and treatment chemicals and testing equipment, as described in this Section.
 2. Supervise the hydronic system flushing, cleaning, passivating process performed by the Division 23 Contractor.
 3. Provide all chemicals required for cleaning, passivating, and flushing the systems provided by this project, for initially filling or refilling these systems, and for maintaining these systems at proper concentration levels required for effective, efficient operation of the mechanical equipment for a period of one (1) year after the acceptance of the project by the Client Agency, as described herein.
 4. Determine the volume of each system using the make-up flow meter or similar methods to determine the correct dosing levels of cleaners and treatment chemicals.
 5. Provide all water chemical treatment equipment as required to implement the chemical treatment programs specified. All chemical treatment equipment shall become the property of the Client Agency.
 6. Instruct HVAC Contractor on installation of chemical feeding equipment.
 7. Provide startup assistance for and supervision of Division 23 Contractor to flush the systems, clean with detergents and passivators, and initially fill systems with required chemical treatment prior to operation.
 - a. Direct flushing, cleaning and/or disinfection, pretreatment, metal passivation, startup and debugging operations.
 - b. Direct and perform chemical control tests during both construction and the warranty period.

8. Provide the Architect with complete written instructions in shop manual format for chemical feeding and test procedures.
 9. Demonstrate to the Client Agency the proper application of the written instructions.
 10. Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion and scale formation for closed loop hydronic piping and equipment. Services and chemicals shall be provided for a period of one (1) year from date of Substantial Completion. Refer to the "Maintenance Service" Article in this Section.
- E. The Division 23 Contractor shall install all feeding equipment; such equipment shall become the property of the Client Agency. The Contractor shall be responsible for all wiring, piping, valves, fittings, switches and miscellaneous equipment required for water treatment.
- F. Establish and maintain the following water quality for closed loop hydronic systems, subject to review of requirements of the boiler manufacturer for heating systems for the entirety of the warranty period:
1. pH: Maintain a value within 8.0 to 10.0.
 2. Conductivity: Maintain a maximum value of 3,000 micromho/cm (microSiemens/cm)
 3. Total Alkalinity as CaCO₃: Maintain a value within 20 to 250 ppm.
 - a. Use an offsite water source if the make-up total hardness exceeds 200 ppm. Do not artificially soften the water.
 4. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
 5. Total Suspended Solids (TSS): Maintain a maximum value of 10 ppm.
 6. Total Dissolved Solids (TDS): Maintain a maximum value of 3,000 ppm.
 7. Dissolved Oxygen: Maintain a maximum of 5 ppm, but no less than 1 ppm (to ensure molybdate efficacy)
 8. Turbidity: Maintain a value less than 15 NTU.
 9. Boron: Maintain a value within 100 to 200 ppm.
 10. Soluble Iron: Less than 2 ppm.
 11. Soluble Copper: Maintain a maximum value of 1 ppm.
 12. Chloride: Maintain a maximum value of 125 ppm.
 13. Sulfate: Maintain a maximum value of 250 ppm.
 14. Ammonia: Maintain a maximum value of 2 ppm.
 - a. Provide an activated carbon filter on the make-up water supply as required to remove chloramine (source of ammonia).
 15. Phosphates: less than 1 ppm. (as ortho-phosphate, PO₄) - except in glycol solutions, where higher levels are permitted when they are a result of the use of a herein specified inhibited glycol product.
 16. Foam: None visible in samples.
 17. Microbiological Limits:
 - a. Total Aerobic Plate Count: Maintain a maximum value of 1,000 organisms/mL.
 - b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/mL.
 - c. Nitrate Reducers: Maintain a maximum value of 100 organisms/mL.
 - d. Sulfate Reducers: Maintain a maximum value of zero organisms/mL.
 - e. Iron Bacteria: Maintain a maximum value of zero organisms/mL.

2.3 MANUAL CHEMICAL-FEED EQUIPMENT

- A. One-Shot Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch funneled fill opening and air release valve in the top, drain valve on bottom, and NPS 3/4 bottom inlet and top side outlet for connection to the hydronic system. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
 - 1. Capacity: 5 gal.
 - 2. Minimum Working Pressure: 125 psig.

2.4 SMALL SYSTEM GLYCOL SOLUTION FEEDER (MAKE-UP) UNIT

- A. The package shall consist of a steel base, 6 gallon polyethylene tank with removable lid and visible solution level scale in gallons and liters, a single self-priming positive displacement type pump that can run dry without damage, pump isolation and check valve, pressure gauge on outlet, pressure switch for automatic control of pump, relief valve with return line, and necessary interconnecting piping.
- B. The unit shall provide no less than 0.7 GPM and maintain a fill pressure of up to 40 PSI, or as otherwise noted on the Drawings.
- C. System shall have a 115/1/60 single point hardwired power connection, with an integral disconnect switch. A plug-in type connection is also acceptable however a twist lock receptacle shall be furnished to the Division 26 Contractor for installation at the feeder. The Division 23 Contractor shall pay for any electrical installation costs associated with the receptacle.
- D. Automatic pump operation shall be upon a fall in system pressure, and shall stop upon reaching pressure setpoint. Unit to include a low level cutout to stop the pump during low level condition.
- E. The unit shall have a 1/2" NPT system piping connection.

2.5 CHEMICALS

- A. Water treatment chemicals shall be compatible with piping system components and connected equipment. Chemicals and chemical concentrations shall be as recommended by water treatment service provider and implemented as required in order to attain water quality specified in the "Performance Requirements and Scope of Services" Article herein.
- B. Closed System Water Chemical Treatment Program: Sequestering agent to reduce deposits and adjust pH, non-oxidizing biocides to control biological growth, corrosion inhibitors, and oxygen scavengers (to reduce dissolved oxygen from make-up water when necessary, such as during initial treatment, after system modifications, etc.).
 - 1. Corrosion Inhibitors: All inhibitors and inhibitor blends shall be designed and selected specifically for mixed-metallurgy systems containing aluminum, copper, brass, stainless steel, cast iron, and carbon steel. The system pH shall be adjusted to a range required for the inhibitor used, and this pH range shall be acceptable to the boiler manufacturer.

- a. Heating Hot Water Systems Operating at times above 130 deg. F.: Nitrite, molybdate, and azole.
 - b. All Other Closed Loop Hydronic Systems: Molybdate and azole. (Nitrite is not permitted.)
 - c. Use of nitrite only in lieu of use of molybdate as specified herein is not acceptable. Other types of inhibitors not specified herein, such as chromate, PEHA, HEHA, silicates, sulphite, hydrazine, etc. shall not be used.
 - a) Exception: Where the local sewer authority strictly prohibits the discharge of molybdate in the specified concentrations. In such cases, silicates and/or nitrite may be used in substitution, however the concentration of nitrite and it's potential for contributing to biological growth shall be carefully monitored in systems other the heating hot water loops. Silicates may not be used in systems with temperatures that exceed 160 deg. F.
 - d. Required Concentrations:
 - 1) Molybdate as MoO4: maintain a level of 300 to 450 ppm.
 - 2) Azole in the form of tolytriazole (TTA): No less than 10 ppm total, with greater than 5 PPM free and available.
 - 3) Nitrite (steel corrosion protection) as NO2: maintain a level of 800 to 1,200 ppm, except in systems that do not ever operate above 130 deg. F. where nitrite shall not be used.
2. Dispersants: Inhibitor blends shall include polymer dispersing agents to minimize the potential for the formation of CaCO₃ scale deposits.
3. Biocides: Non-oxidizing, non-cationic type, with bio-dispersant agents.
4. Oxygen Scavengers: Buffered, catalyzed sodium sulphite.
5. pH Buffers: Borates.
- C. System Cleaner: Commercially available liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products. Cleaner shall also provide for metal passivation, and shall form a corrosion resistant film on metallic surfaces to prevent 'flash corrosion'. Cleaners shall be compatible with the piping system materials. Special care shall be taken with systems that contain galvanized steel and aluminum.
- 1. A separate cleaning agent and passivating agent may be provided in lieu of an all-in-one cleaner/passivator product, but chemical compatibility shall be verified.
 - 2. Acceptable cleaners / passivators are the following:
 - a. GE 'Ferroquest 7101' (Note: Do not use on systems containing galvanized metals.)
 - b. Nalco Water '3D TRASAR'
 - c. Chem-Aqua '61502' with Chem-Aqua '32115'
 - d. Sentinel 'X300'.
 - e. Approved equal.

2.6 PROPYLENE GLYCOL/WATER SOLUTION

- A. Provide a commercial inhibited propylene glycol solution formulated specifically for use in hydronic systems. Fill the system to the level of concentration indicated on the Drawings. The glycol shall meet the corrosion limit requirements of ASTM D-1384. The glycol shall be dyed a fluorescent color to assist in leak detection.
- B. Glycol/water solution shall be pre-mixed with de-ionized water conforming to ASTM D1193, Type II reagent water standard.
 - 1. The use of local, on-site water is prohibited.
- C. Advise the Client Agency as to which types of corrosion inhibitors are present in the inhibited glycol product, and which types of inhibitors may be added in the future that will not react with the inhibitors present in the glycol (and potentially form harmful precipitates).
 - 1. Provide supplemental corrosion inhibitors and biocides to protect the piping system from corrosion and biofilm formation. If the supplemental inhibitors are not provided by the glycol manufacturer, verify compatibility with the glycol with the glycol manufacturer prior to adding the supplemental chemicals. Provide proof of this verification by way of a letter submitted to the Architect / Engineer.
- D. The coolant manufacturer shall analyze the fluid bi-annually to ensure the glycol water solution continues to provide corrosion protection within industry standards and at no cost to the Client Agency.
- E. The Contractor shall conduct refractometer tests initially and periodically over the warranty period to assure that a proper mixture is maintained.
- F. Fill Process: After the system has been flushed, cleaned, rinsed, it shall be immediately filled with the inhibited glycol solution to the required concentration. The Contractor shall meter the initial water fill for the purpose of hydrostatic pressure testing and/or system flushing. This will allow for any adjustments required prior to delivery of the premixed glycol solution. Should the concentration still require adjustment after the system has been filled and as a result of trapped water, then drain the required amount of fluid from the system and replace it with the same manufacturers coolant in its concentrated form. Repeat this process until the required concentration is achieved.
- G. Final Concentration Verification Test: Circulate the glycol water mixture for 24 hours before a sample is taken and tested for the proper concentration, freeze point, reserve alkalinity and pH. Advise the Client Agency in writing of the exact type of glycol and supplemental corrosion inhibitors, total amount provided, and guaranteed lowest outdoor ambient temperatures at which gelling and freezing will be prevented.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

- A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 EQUIPMENT INSTALLATION AND CONNECTIONS

- A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.
- B. Piping installation requirements are specified in other Division 23 Sections. The Drawings indicate the general arrangement of piping, fittings, and specialties.
- C. Where installing piping adjacent to equipment, allow space for service and maintenance.
- D. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings.
- E. Install shutoff valves on HVAC water-treatment equipment inlet and outlet.
- F. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.
- G. For glycol containing systems, label all system drain valves with "Contains Glycol - DO NOT DRAIN".
- H. Ground equipment and connect wiring according to applicable electrical requirements in electrical Division 26 Sections for connecting electrical equipment.

3.3 PIPING SYSTEM FLUSHING AND CLEANING

- A. Refer to Division 23 Section 232113, "Hydronic Piping", for additional requirements.
- B. Flush the system clear of debris. Flush the system till the water runs visibly clear and has an electrical conductivity no more than 100 microSiemens greater than that of the fresh water supply. Verify that equipment is bypassed during the flushing operation.
- C. Place terminal control valves in OPEN position during cleaning and verify that equipment is no longer bypassed.
- D. Use water meter to record the volume of each system to determine the correct dosing levels of cleaners.
- E. Add cleaning chemicals. Cleaning chemical shall provide both chemical passivation and dissolution of oils and grease as herein specified. Provide anti-foaming agent as required.
 - 1. Hot-Water Heating- System: Apply heat while circulating, slowly raising system to design temperature; maintain for a minimum of 24 hours. Remove heat and allow to cool; drain and refill with clean water. Circulate for 12 hours at design temperature, then drain. Refill with clean water and repeat until system cleaner is removed, as evidenced by tests showing the drain water to have the same pH, conductivity, TDS, iron, phosphate, and chloride levels as the make-up water source.

3.4 BOILER WATER TREATMENT REQUIREMENTS SIGNAGE

- A. Post in near proximity to each boiler and the closed loop system chemical feeding equipment permanent framed signage indicating all system water quality and treatment requirements, including those reflecting the recommendations of the boiler manufacturer (pH, etc.).
- B. The final language shall be coordinated between the Water Treatment Service Provider performing work of this Section, and the boiler manufacturer's representatives, and shall be submitted to the Architect / Engineer as an informational submittal.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
 - 1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
 - 2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
 - 3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of hydronic systems' startup procedures.
 - 4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
 - 5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 6. Leave uncovered and unconcealed new, altered, extended, and replaced hydronic piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
 - 7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
 - 8. Repair leaks and defects with new materials and retest piping until no leaks exist.
- B. Equipment will be considered defective if it does not pass tests and inspections.
 - 1. Prepare initial test and inspection reports.

3.6 MAINTENANCE SERVICE

- A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for closed-loop water piping and equipment. Services and chemicals shall be provided for a period of one (1) year from date of Substantial Completion and shall include the following:
 - 1. Initial water analysis and hydronic water-treatment recommendations.
 - 2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
 - 3. Periodic field service and consultation.

4. Customer report charts and log sheets.
 5. Laboratory technical analysis.
 6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.
 7. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program and make recommendations in writing based upon these inspections.
- B. After the initial analysis and treatment during system start-up, at six (6)-week intervals following Substantial Completion, perform separate water analyses on each closed loop to observe if the systems are maintaining water quality within performance requirements specified in this Section. Make all required changes and submit written reports of water analysis advising Client Agency of changes made to adhere to the provisions of the "Performance Requirements and Scope of Services" Article herein. Glycol percentage and type must be listed on test results.
1. A total of nine (9) analyses, etc. are required for the period of maintenance service.
 2. Comply with ASTM D 3370 and with the following water testing standards:
 - a. Silica: ASTM D 859.
 - b. Acidity and Alkalinity: ASTM D 1067.
 - c. Iron: ASTM D 1068.
 - d. Water Hardness: ASTM D 1126.
- C. Provide a project closeout report and ongoing maintenance plan to the Client Agency at the end of the 1-year maintenance warranty period. The report shall include:
1. Domestic water test results
 2. Initial startup water test results
 3. Water test results during warranty period
 4. System maintenance schedule
 5. Final water test results, at conclusion of warranty period.
 6. Observed system leakage rate for each system for each regular (6 week) analysis interval as well as for the full 1 year warranty - absolute value and as a percentage of the system volume. Make recommendations for corrective actions when system leakage rate exceeds 4% of system volume per year, or 0.4% per month.

3.7 TRAINING AND DEMONSTRATION

- A. Provide services to instruct Client Agency's personnel in operation, maintenance, and testing procedures of water treatment system.
1. Arrange course at startup of systems.
 2. Review procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
 3. Review data in the operation and maintenance manuals.
- B. Schedule training with Client Agency, through the Architect, with at least 7 days' advance notice.

END OF SECTION

SECTION 233113

DUCTWORK

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.
- B. Related Division 23 Sections include the following:
 - 1. "Vibration Controls for HVAC" for ductwork vibration isolators.
 - 2. "HVAC Duct Insulation" for duct insulation.
 - 3. "Air Duct Accessories" for dampers, sound-control devices, duct-mounted access doors and panels, turning vanes, flexible ducts, and other duct mounted specialties.
 - 4. "Diffusers, Registers, and Grilles" for air inlets and outlets.
 - 5. "Testing, Adjusting, and Balancing for HVAC" for air balancing and final adjusting of manual-volume dampers.

1.2 SUMMARY

- A. This Section includes rectangular and round metal ducts and plenums for heating, ventilating, and air-conditioning systems in pressure classes from minus 10- to plus 10-inch wg. Products specified herein include the following:
 - 1. Single-wall, rectangular ducts and fittings.
 - 2. Single-wall round spiral-seam ducts and formed fittings.
 - 3. Sealants and gaskets.

1.3 INTERPRETATION OF THE DRAWINGS

- A. Duct system design, as indicated, has been used to select and size air-moving and -distribution equipment and other components of air system. Ductwork indicated on the Drawings is schematic; therefore, changes in ductwork sizes and/or location shall be made when necessary to conform to project conditions. Offsets, rises, drops, and duct profile changes shall be made at no additional cost to the Client Agency. The Architect / Engineer shall be consulted for approval of duct size changes which cannot maintain the same equivalent flow area and friction rate, require a duct aspect ratio exceeding 4 to 1, or represent a fundamental change to the configuration of duct system. Proposed changes must be specifically approved in writing by Architect / Engineer prior to being implemented. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

- B. Duct dimensions indicated on Drawings are the required clear, inside dimensions. Adjust sheet metal dimensions to account for duct liner or double wall construction. Note that, typically, the first dimension listed on the Drawings is that of the side visible in the particular 2D view (plan, section, etc.).
- C. The Drawings schematically indicate fitting types. All proposed changes in fitting types shown on the Drawing or specified in this Section shall be approved in writing by the Architect / Engineer prior to being implemented.
- D. Turning vanes not shown on the Drawings for mitered rectangular elbows have been omitted for clarity purposes only. The Contractor shall provide turning vanes as required by this Section regardless of drawing depiction.
 - 1. At the Contractor's option, radius type elbows with 1.5 or 1.0 centerline radius to duct width ratio may be provided in lieu of mitered elbows shown on the Drawings where the duct width in the plane of change in direction is less than 14", provided that the elbow fits in the space available.
 - 2. Mitered elbows shall not be substituted for a radius type elbows shown on the Drawings unless specifically approved by the Architect / Engineer.

1.4 ACTION SUBMITTALS

- A. Product Data: For prefabricated ductwork, duct components sealant and gasket materials.
- B. Shop Drawings: Show details of the following:
 - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 2. Factory- and shop-fabricated ducts and fittings.
 - 3. Duct layout indicating sizes, configuration, and pressure classes.
 - 4. Elevations of top and bottom of ducts.
 - 5. Dimensions of main duct runs from building grid lines.
 - 6. Fittings.
 - 7. Reinforcement and spacing.
 - 8. Seam and joint construction.
 - 9. Penetrations through fire-rated and other partitions.
 - 10. Penetrations through exterior walls.
 - 11. Equipment installation based on equipment being used on Project.
 - 12. Duct accessories, including dampers and access doors.
 - 13. Hangers and supports, including methods for duct and building attachment, and vibration isolation.
 - 14. Control dampers and all other control devices required.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Refer to Division 23 Section "Common Work Results for HVAC" for additional coordination drawing requirements. Show the following:

1. Ceiling suspension assembly members.
2. Other systems installed in same space as ducts.
3. Ceiling- and wall-mounted access doors and panels required to provide access to dampers and other operating devices.
4. Coordination with ceiling-mounted items, including lighting fixtures, diffusers, grilles, speakers, sprinkler heads, access panels, and special moldings.
5. Other items required to be included as per the provisions of Division 23 Section "Common Work Results for HVAC".

B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements for the following:

1. Pressure and leakage tests.

1.6 CLOSEOUT SUBMITTALS

A. Record Drawings: Indicate actual routing, fitting details, reinforcement, support, and installed accessories and devices.

1.7 QUALITY ASSURANCE

A. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): Generally, ductwork and ductwork supports shall meet the requirements of SMACNA's Publication "HVAC Duct Construction Standards--Metal and Flexible", 3rd Edition (2005), and various other SMACNA Publications referenced in this specification section. However, where the requirements of this specification section exceed SMACNA requirements or where a prohibition of specific type of work contained in the SMACNA standard is made, the requirements of this specification section shall take precedence.

B. Minimum Seal Class Requirements: Conform to requirements of 2015 International Energy Conservation Code, the referenced SMACNA standards and ASHRAE Standard 90.1- 2013 except where these specifications exceed those requirements.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver sealant and firestopping materials to site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle sealant and firestopping materials according to manufacturer's written recommendations.

C. Protect shop fabricated and factory fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings with a polyethylene film with a high-tack adhesive to attach to the ductwork and accessories. Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclose with polyethylene waterproof wrapping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
1. Single Wall Round Prefabricated Ducts and Fittings:
 - a. Hranec Sheet Metal Inc.
 - b. Linx Industries Inc.
 - c. McGill AirFlow LLC
 - d. MKT Metal Manufacturing
 - e. SEMCO LLC
 - f. Sheet Metal Connectors, Inc.
 2. Round Prefabricated Connectors:
 - a. Ductmate Industries, Inc.
 - b. Hranec Sheet Metal Inc.
 - c. Linx Industries Inc.
 - d. McGill AirFlow LLC
 - e. MKT Metal Manufacturing
 - f. SEMCO LLC
 - g. Sheet Metal Connectors, Inc.
 3. Sealant and Gaskets:
 - a. Ductmate Industries
 - b. Carlisle Hardcast
 - c. Childers; a Div. of HB Fuller Construction Products Inc.
 - d. McGill Airflow LLC
 - e. Foster; a Div. of HB Fuller Construction Products Inc.
 4. Flanged Duct Connector Systems for Rectangular Duct:
 - a. Ductmate '35' and '45' systems.
 - b. CL Ward "J" and "H" flange and corner systems.
 - c. Hardcast / Nexus "J" and "G" flange and corner systems.
 - d. Ward Industries / Hart and Cooley "FLGJ" and "FLGH" systems
 - e. Note: SMACNA joint types T-25a and T-25b (TDC and TDF type connectors, respectively) using corner pieces provided by the above listed manufacturers are also acceptable on ducts where the pressure class does not exceed 2" w.g., positive or negative.
 5. Flanged Duct Connector Systems for Round Duct:
 - a. Ductmate 'Spiralmate'.

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Steel Cable Hanger Systems:
 - a. Ductmate 'Clutcher'
 - b. DuroDyne 'Dyna-Tite' Series
 - c. Gripple Inc. 'Standard Hanger' Series

2.2 SHEET METAL MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, except as otherwise indicated or modified by this Section. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized, Sheet Steel: Lock-forming quality; ASTM A 653 or ASTM A 924, G60 coating designation. Minimum thickness permitted shall be 24 gauge, except for round spiral seam ductwork which shall have a minimum thickness of 26 gauge.
 - 1. Exception: Outdoor air intake ducts (unconditioned air) shall be constructed of galvanized steel sheet with a minimum G90 (or higher) coating designation (unless such ducts are indicated elsewhere to be constructed of a material other than galvanized steel).
 - a. At the Contractor's option, in lieu of the higher galvanizing level on outdoor air intake ducts located indoors.
 - 1) Construct the ductwork of ASTM B 209, Alloy 3003, Temper H14 aluminum sheet, minimum 20 gauge thickness.
- C. Aluminum Sheets: ASTM B 209, Alloy 3003, Temper H14, sheet form with standard, one-side bright finish for ducts exposed to view and with mill finish for concealed ducts. Minimum thickness permitted shall be 22 gauge.
- D. Reinforcement Shapes and Plates: Galvanized steel reinforcement where installed on galvanized, sheet metal ducts; matching materials for aluminum ducts.
- E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches. Maximum diameter permitted is 1/2".
 - 1. For aluminum ducts, provide matching materials.

2.3 SEALANT AND GASKETS

- A. Tapes: One-step (peel and stick) pressure-sensitive duct sealing tapes, two-part tape systems, and similar sealing tapes are not permitted for sealing metal duct joints and penetrations.

- B. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL. Sealants shall be UL-181B-M listed.
- C. Indoor Duct Water-Based Joint and Seam Sealant:
1. Application Method: Brush-on or trowel-on to minimum 1/16" thickness to joints and seams. Application temperature range: 40 to 100 deg F.
 2. Solids Content: Minimum 68 percent.
 3. Shore A Hardness: Minimum 72.
 4. Shall be permanently flexible and water, mold, and mildew resistant after curing.
 5. Adhesion Strength per ASTM C794 to Bright Annealed Stainless Steel: 6.25 PLI
 6. VOC Content: Maximum 30 g/L (less water).
 7. UL 181B-M listed; UL 723 Classified.
 8. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 9. Service Application: Indoor duct installations, except for unconditioned outdoor air ducts.
 10. Acceptable Products: Ductmate 'PROseal', Foster '32-19 Duct-Fas', or Childers 'Chil-Flex CP-146'.
- D. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
 2. Type: S.
 3. Grade: NS.
 4. Class: 25.
 5. Use: O.
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
1. Comply with UL 723 and meet Mil-C 18969B and TTS-S-001657. This material, in addition to the above, shall not contain vegetable oils, fish oils, or any other type vehicle that will support fungal and/or bacterial growth.
 2. The use of gaskets with adhesive properties on fitting and duct connections shall not substitute for fastening hardware.
- F. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.4 HANGERS AND SUPPORTS

- A. Supports shall comply with Chapter 5 of the SMACNA Publication "HVAC Duct Construction Standards--Metal and Flexible, 3rd Edition, 2005, except as modified by this section.

- B. Building Attachments: fasteners appropriate for building materials.
1. Do not use strap type attachments or friction type beam clips / clamps (e.g. hammer-on / slide-on flange clips and similar devices).
 - a. C-type beam clamps that incorporate a bolt for fastening, consistent with MSS Types 19 and 23, are acceptable.
- C. Hanger Materials: Galvanized, sheet steel straps, wire rope locking cable hanger system or round, threaded steel rod. Strap galvanizing shall be G90, or matching that of the supported duct, whichever is greater.
1. Exceptions to the Above:
 - a. Hangers and supports for aluminum duct shall be constructed of 6061-T6 aluminum or galvanized steel and isolated from the aluminum with an epoxy paint finish. Reinforcements shall be made of 6061-T6 aluminum.
 2. Straps and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for sheet steel width and thickness and for steel rod diameters.
 3. Do not use wire hangers unless explicitly specified elsewhere in this Section.
- D. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
1. Fasteners for interior galvanized ducts shall be zinc or cadmium coated.
 2. Fasteners for interior aluminum ducts shall be stainless steel.
 3. Blind rivets using pull-through mandrels are not permitted if they leave holes for air leakage. Fasteners shall not project into duct interiors more than 1/2".
- E. Trapeze and Riser Supports: Steel shapes shall comply with ASTM A 36.
1. Supports for Galvanized-Steel Ducts: Galvanized steel shapes and plates.
 2. Supports for Aluminum Ducts: Aluminum support materials Aluminum shapes shall comply with ASTM B 221.
- F. Steel Cable Hanger Systems: Factory-fabricated system of steel wire cables, locking cable anchors, and related accessories for the support of horizontal ducts which do not exhibit, or have been restrained from, lateral movement during system operation. All products shall be from a single manufacturer, and shall have been tested by SMACNA Testing and Research Institute and found to conform to the requirements of the "HVAC Duct Construction Standards, Metal and Flexible" for upper and lower attachments. Hangers shall be factory engineered for a 5 to 1 safety factor.
1. Steel Cables: Galvanized steel complying with ASTM A 603 or Stainless steel complying with ASTM A 492.
 2. Steel Cable Locks / End Connections: Cadmium or zinc-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

3. Stress Distribution Corner Guards: Used with uninsulated rectangular duct to prevent cable stress or deformation of the ductwork. Corner brackets are an acceptable alternative so long as the ductwork is not material handling or of fully welded construction.
4. Acceptable Upper Attachments Are Limited to the Following:
 - a. Cable loops around building structural steel and supplemental steel where the minimum required cable bending radius is ensured, and channel support system attachments in steel structure buildings.

2.5 RECTANGULAR DUCT FABRICATION – GENERAL REQUIREMENTS

- A. General: Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" (3rd Edition; 2005), except as modified by this Section. Comply with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
 1. Transverse joint types are limited to the following:
 - a. T-1 through T-14 as shown in Figure 2-1, "Rectangular Duct/Transverse Joints" in the above referenced SMACNA standard, for ductwork in the 1/2" or 1" w.g. (positive or negative) pressure classes.
 - b. Flanged duct connector systems as elsewhere specified in this Section.
 - c. Joint types explicitly specified elsewhere in this Section.
 2. Longitudinal joint types are limited to joint types shown in Figure 2-2, "Rectangular Duct/Longitudinal Seams" in the above referenced SMACNA standard, except for L-2 (button punch snap lock) and L-3 (grooved seam), which are not permitted. Joint types explicitly specified elsewhere in this Section are also permitted.
- B. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
- C. Materials: Free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.
- D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359-inch-thick or less, with more than 10 sq. ft. of unbraced panel area, unless ducts are lined.

2.6 FLANGED DUCT CONNECTOR SYSTEMS

- A. A pre-fabricated flanged duct connector system is acceptable for forming transverse joints on rectangular and round ductwork where the specified pressure class can be met, and subject to other restrictions herein indicated.
- B. The system shall consist of factory-fabricated add-on flange connectors, gaskets, and related components and fasteners. Materials shall be galvanized steel, aluminum to match the connecting ductwork. The system shall be suitable for ductwork having pressure ratings from +2 inches w.g. to +10 inches w.g. and from -2 inches w.g. to -10 inches w.g. The system flanges and corner

pieces shall form a flange frame around the full perimeter of the duct, and shall be designed to produce a sealed fit onto a plain duct end using an integrated sealant pocket.

1. 'Formed-on' style flanges, such as SMACNA joint types T-25a and T-25b (TDC and TDF type connectors, respectively) and similar joining methods using a flange that is formed directly from the duct end, are acceptable where the pressure class does not exceed 2" w.g., positive or negative.
 2. Boltless connections on rectangular duct are not acceptable. The system shall utilize no less than one bolt per corner.
- C. The duct connector system shall be applied in full conformance with the system manufacturer's installation instructions and with all required sealants, gaskets, bolts, nuts, washers, and spring clip / cleats.
1. Substitution of zip screws for the recommended galvanized steel spring clips (cleats) will not be permitted. Spring clips shall be of the length, gauge, and quantity recommended by the system manufacturer.
- D. Flange Gaskets: Permanently flexible butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
1. Comply with UL 723 and meet Mil-C 18969B and TTS-S-001657. This material, in addition to the above, shall not contain vegetable oils, fish oils, or any other type vehicle that will support fungal and/or bacterial growth.

2.7 ROUND DUCT FABRICATION

- A. Round Ducts: Fabricate ducts with standard spiral lock seams according to Figure 3-2 of SMACNA's "HVAC Duct Construction Standards--Metal and Flexible", 2005 (3rd Edition).
1. Snap-lock, lapped and riveted, butt weld, and grooved type longitudinal seam construction is not acceptable.
- B. Transverse Joints Between Duct Sections and to Fittings: Fabricate according to Figure 3-1 of the above referenced SMACNA standard.
1. Ducts up to 20 Inches in Diameter: Factory fabricated slip-on gasketed flange system or type 'RT-1' beaded sleeve joint consisting of an interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
 2. Ducts 21 to 72 Inches in Diameter: Factory fabricated slip-on gasketed flange system or a type 'RT-2' Van Stone joint consisting of a gasketed, flanged joint with two internal flanges formed on the duct end, two exterior flanges, and flange hardware.
 3. Ducts Larger than 72 Inches in Diameter: Type 'RT-2A' companion angle flanged joints.
 4. Gasketed Push-On Joints (all sizes): Refer elsewhere in this Section for requirements for round duct joint O-ring seals:
 - a. Round Ducts: Factory-fabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.

5. Draw-band, crimp joint sleeve, swedge bell, and outside sleeve joints are not acceptable.

2.8 ROUND FITTING FABRICATION

- A. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," 2005, with metal thicknesses specified for spiral lock seam straight duct.
- B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from body onto branch tap entrance.
- C. Elbows: Fabricate in die-formed (stamped), gored (segmented), or pleated construction. Single-mitered and adjustable type elbows are not permitted on round ductwork. Fabricate with a centerline bend radius of at one and one-half times elbow diameter. Fabricate elbows as follows:
 1. Round Elbows, 12 Inches and Smaller: Fabricate die-formed elbows for 45- and 90-degree elbows, and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configuration or nonstandard diameter elbows with gored construction.
 2. Round Elbows, Larger than 12 Inches: Fabricate gored (segmented) elbows. Maximum 22.5 degree change in direction per segment (e.g. this requires a 5-segment elbow for a 90 degree change in direction, and elbows with less than 90-degree change of direction shall have proportionately fewer segments.).
 3. Die-Formed Elbows for Sizes through 8 Inches and All Pressures: 0.040-inch-thick with two-piece welded construction.
 4. Round Gored (Segmented)-Elbow Metal Thickness: Same as non-elbow fittings specified above.
 5. Pleated Elbows for Sizes through 12 Inches and Pressures through 10-Inch wg: 0.028 inch.

PART 3 - EXECUTION

3.1 DUCT APPLICATIONS

- A. Refer to Division 23 Section "Common Work Results for HVAC" for definitions of 'conditioned' and 'unconditioned' spaces.
- B. Select and construct and seal duct systems components (ducts, fittings, and accessories) in accordance with the following SMACNA Static-Pressure and Seal Classes. The pressure ratings indicated are minimum values:
 1. Ducts Located in Interior Conditioned and Indirectly Conditioned Spaces: Unless otherwise indicated, construct ducts to the following:
 - a. Return and Relief Air Ducts: -2-inch w.g., Seal Class "C".
 - b. Unconditioned Outside Air Ducts: -1-inch w.g., Seal Class "A".
 - c. Exhaust Air Ducts: -2-inch w.g., Seal Class "B".
 - d. All supply and relief air ducts not addressed by the above sub-paragraphs shall be +2" w.g., Seal Class "A".

- C. Material Application: All ducts shall be galvanized steel, except as follows:
 - 1. All exhaust ductwork associated with shower rooms: Aluminum.
 - 2. Any ducts / duct systems specifically noted on the Drawings to be a material other than galvanized steel.
- D. All ducts shall be single wall.

3.2 DUCT FITTING APPLICATIONS

- A. Elbow Configuration: Unless explicitly noted otherwise on the Drawings, use the following elbow types:
 - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows", as modified below. NOTE: All radii listed below are to the centerline of the duct, in the plane of change of direction.
 - a. Supply ducts downstream of terminal units, exhaust and return ducts upstream of terminal units, and constant volume ducts, and duct systems lacking in terminal units and air valves:
 - 1) Radius Type RE 1 with minimum 1.5 centerline radius-to-duct width (r-to-dw) ratio.
 - 2) Radius Type RE 1 with minimum 1.0 r-to-dw ratio.
 - a) These are only permitted where a 1.5 r-to-dw elbow is demonstrated to not possibly fit in the available space by way of the ductwork shop drawing and coordination drawing review and approval process.
 - 3) Mitered Type RE 2 with small single-wall vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible, 2005" Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 - b. Supply ducts upstream of terminal units, return and exhaust ducts downstream of terminal units and air valves:
 - 1) Radius Type RE 1 with minimum 1.5 centerline radius-to-duct width (r-to-dw) ratio.
 - 2) Radius Type RE 3 with minimum 1.0 r-to-dw ratio and splitter vane(s) complying with Chart 4-1 and Figure 4-9 of SMACNA's "HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition (2005)".
 - a) Ducts less than 12" wide: Provide 1 splitter vane.
 - b) Ducts from 12" to 36" wide: Provide two (2) splitter vanes.
 - c) Ducts wider than 36": Provide three (3) splitter vanes.
 - 3) Mitered Type RE 2 with small single-wall vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition (2005)" Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

- c. All other elbow types (e.g. RE 4 un-vented square/mitered ells, RE 5, 6, 7, 8, 9, or 10 ells, and square throat / radius heel, etc.) are not permitted, except where explicitly shown on the Drawings.
 - 1) Exception: Type RE 4 (un-vented and mitered) ells are permitted in transfer-air ducts, and in ducts where the peak / design velocity is less than 800 feet per minute.
- 2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible, 2005" Figure 3-4, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio:
 - 1) 1.0 centerline radius-to-diameter ratio for 90-degree elbow. These are only permitted where a 1.5 centerline radius-to-diameter elbow is demonstrated to not possibly fit in the available space by way of the ductwork shop drawing and coordination drawing review and approval process.
 - 2) 1.5 centerline radius-to-diameter ratio for 90-degree elbow.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Segmented (gored) with standing seams or welded joints. Maximum 22.5 degree change in direction per segment (e.g. this requires a 5-segment elbow for a 90 degree change in direction, and elbows with less than 90-degree change of direction shall have proportionately fewer segments.)
- B. Branch Configuration: Unless explicitly noted otherwise on the Drawings, use the following branch-to-main connection types:
 - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connections."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry, except as indicated on the Drawings.
 - b. Rectangular Main to Round Branch: Flanged or spin-in bellmouth or conical tap.
 - 1) Where the height of the duct main is insufficient to permit a bellmouth or conical tap, provide a round-to-rectangular transition on the branch duct so that a rectangular 45 degree entry connection to the main duct can be made. The transition shall be to a height equal to the main duct height, and to a width as required to maintain equal or greater total flow area as the connecting round branch duct.
 - 2) Plain, straight (e.g. constant diameter round) taps are not acceptable.
 - 2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90-Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are only permitted for new branches on existing ducts.
 - a. Conical tap, 90-degree tee with oval-to-round tap, or 45-degree lateral tap. Plain taps are not permitted.
- C. Rectangular Duct Divided Flow Branches: Type 1 or 2 of the referenced SMACNA Standard.

- D. Vertical and Horizontal Offsets: Full duct dimensions shall be maintained. Use a pair of elbows complying with the above provisions. Elbows with the smallest number of degrees of change in direction that will possibly fit in the available space shall be used. Offset types shown the referenced SMACNA Standard are not acceptable.
- E. Transitions: Changes in duct sizes shall be made with uniformly sloping transitions.
 - 1. Transitions from a larger to a smaller duct in the direction of flow in either duct depth or height shall have not more than a 45 degree angle parallel to the airflow for a one sided transition, or 22.5 degree angle for a two sided transition (i.e. 22.5 degrees on each side, for 45 degrees total).
 - 2. Transitions from a smaller duct to a larger duct in the direction of flow in either duct depth or height shall have not more than a 30 degree angle parallel to the airflow for a one sided transition, or 15 degree angle for a two sided transition (i.e. 15 degrees on each side, for 45 degrees total).

3.3 DUCT INSTALLATION, GENERAL

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on shop drawings and coordination drawings.
- B. Construct and install each duct system for the specific duct pressure classification specified.
- C. Install round ducts in lengths not less than 12 feet, unless interrupted by fittings.
- D. All ductwork shall be constructed to be free from vibration, chatter, objectionable pulsations and leakage under specified operating conditions. Provide additional external reinforcement to prevent visible or audible vibration of the duct walls.
- E. Install ducts with fewest possible joints.
- F. Install fabricated fittings for changes in directions, changes in size and shape, and connections.
- G. Provide SMACNA small type, single-wall turning vanes in all mitered duct elbows, except for transfer ducts and other clean air ducts with design velocities less than 750 feet per minute. Note that vanes may not be explicitly shown on the Drawings for clarity purposes only.
- H. Install couplings tight to duct wall surface with a minimum of projections into duct.
- I. Install ducts, unless otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs.
- J. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- K. Successfully pressure and leak test ductwork before applying external insulation.
- L. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

- M. Where ductwork is to be lined with insulation, sizes indicated on the Drawings shall be interpreted as indicating clear dimensions inside the insulation. Adjust actual sheet metal dimensions accordingly. Shape and location of ducts may be changed to suit building conditions but cross-sectional area shall be maintained.
- N. Conceal ducts from view in finished spaces with ceilings. Do not encase horizontal runs in solid partitions, unless specifically indicated.
- O. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.
- P. Electrical Equipment Spaces: Route ductwork to avoid passing through electrical equipment spaces and enclosures. Ductwork not serving transformer vaults is prohibited in such spaces.
- Q. Non-Fire- or Smoke-Rated Partition Penetrations: Where ducts pass through interior partitions, conceal space between construction opening and duct or duct insulation with minimum 22 gauge galvanized steel sheet flanges/frames. Overlap opening on four sides by at least 1-1/2 inches and seal to wall with silicone caulk. Seal sheet metal frame to duct with duct sealant. Tightly pack the width and depth of the annular space between wall opening and duct with ASTM C 665 rock wool batt insulation, min 2.0 lbs./cu. ft. density.
- R. Open Duct Inlets: Provide 1/2" galvanized steel wire mesh screen on open-end duct air inlets (i.e. return and exhaust duct inlets not provided with a grille). Secure screen to flanged duct end with so with a hem and fasteners, with no sharp mesh edges exposed.

3.4 INDOOR AIR QUALITY MANAGEMENT DURING CONSTRUCTION

- A. Containment of Contaminants: The Contractor shall meet or exceed the control measures recommended by SMACNA "IAQ Guidelines for Occupied Buildings Under Construction", 2nd edition (2007) - ANSI/SMACNA 008-2008, in Chapters 3 and 4, to prevent construction dust and other contaminants from escaping the work area or contaminating new HVAC systems and equipment.
- B. Protect stored on-site and installed absorptive materials from moisture damage.
- C. The Contractor shall protect new duct and air system equipment (e.g. fans, AHUs, etc.) interiors from moisture, construction debris and dust, and other foreign materials. During ductwork system installation, keep open ends of ductwork and terminations at registers, grilles, VAV terminal units, and diffusers sealed off and closed with a polyethylene film to prevent entrance of dirt and debris. The film shall be Ductmate 'ProGuard', or approved equal. In addition, the Contractor shall take great care to thoroughly clean and wipe-down all HVAC system components and ductwork above prior and during installation.
 - 1. Comply with SMACNA "Duct Cleanliness for New Construction", 1st edition (2000), published as Appendix G of the SMACNA "IAQ Guidelines for Occupied Buildings Under Construction", 2nd edition (2007).
 - a. Comply with the requirements of "Advanced Level" cleanliness.

- D. HVAC System Start-Up: Delay the start-up of permanent ductwork systems until construction activities that generate large amounts of indoor or exterior airborne particulates have been completed. System startup shall be considered to be a process that involves operating the equipment and systems only as long as it necessary to verify proper operation and installation of the equipment, verification of connections, making adjustments and settings, testing controls, and conducting similar field quality control and commissioning efforts. Successful start-up does not grant the Contractor license to use the permanent systems for construction phase heating and cooling.
1. Start-up of the permanent HVAC systems shall not occur prior to all of the following being met:
 - a. The duct systems being pressure tested and fully insulated and sealed.
 - b. All filters installed, including temporary supplemental filters described below.
 - c. Completion of all drywall sanding and similar dust-generating construction activities performed inside the building, and subsequent clean-up.
 - d. Completed and functioning condensate drainage traps and piping installations.
 - e. Such time that the environmental conditions of the building under construction meet the factory warranty requirements /conditions of all installed HVAC equipment. Factory warranties and their obligations to the Client Agency which have been violated by the Contractor's use of equipment during construction shall become the responsibility of the Contractor for the original factory warranty duration and coverage.
 2. Temporary Supplemental Filters: Operation of the permanent systems for any purpose prior to completion of final cleaning of the building by the General Contractor shall only occur with minimum ASHRAE 52.2 - MERV 10 filter media secured and sealed to each return or exhaust air grille, register, and open ended duct inlet. Filters shall be changed weekly, or more often as needed.
 - a. Outdoor air intakes require an equivalent treatment if outdoor construction activities involve site work generating airborne dust and dirt.
- E. Temporary / Construction-Phase HVAC Services: Do NOT utilize the permanent HVAC systems, or any portion thereof, to provide construction-phase heating, cooling, ventilation, exhaust, or dehumidification required by the construction process until the permanent systems are permitted to operate continuously, and outside of the start-up process, as defined below. Temporary systems shall be provided to meet all HVAC needs prior to that time. Temporary / construction-phase HVAC shall be provided by the General Contractor, unless Division 01 indicates otherwise.
1. Changeover from temporary systems to the use of permanent HVAC system shall not occur prior to Substantial Completion.

3.5 SEAM AND JOINT SEALING

- A. General: Seal duct seams and joints according to the duct pressure classes and seal classes specified and as described in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible", unless more restrictive requirements are indicated in this Section.

- B. Seal and successfully pressure test externally insulated ducts before insulation installation.
- C. Seal duct seams and joints according to the referenced SMACNA standard or this Section, whichever is most restrictive / demanding:
 1. For ducts where Seal Class A is indicated, seal transverse joints, longitudinal seams and wall penetrations (except for damper rod penetrations).
 2. For ducts where Seal Class B is indicated, seal transverse joints and longitudinal seams.
 3. For ducts where Seal Class C is indicated, seal transverse joints only.
 4. Regardless of the Seal Class specified, any joint, seam, or wall penetration through which air leakage makes an audible noise at a distance of 4 feet shall be sealed till the leakage is no longer audible.
- D. All seams and joints in outside air intake ducts and plenums shall be internally coated and sealed water-tight with commercial grade sealant.

3.6 HANGING AND SUPPORTING

- A. Unless otherwise indicated or specified, install rigid round and rectangular metal duct with support systems indicated in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
 1. Supporting ductwork and associated equipment from metal roof and floor decking is prohibited. All ductwork and associated equipment shall be supported from the building structural system.
 2. Ductwork shall be supported directly from the building's steel beams or from miscellaneous structural steel provided by the Division 23 Contractor bearing on steel beams.
 3. Loads supported by steel bar joists exceeding 100 lbs. shall be located at the joist panel points, and shall not impose an eccentric load (twisting moment). Provide supplemental steel and align direct hanger connections to the joists with the joist centerline. Connect to the upper chord of the joist wherever it is possible to do so.
 4. Do not drill or cut building structural steel.
- B. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- C. Support vertical ducts with steel or aluminum angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet. Angles bearing on floors shall overlap the floor opening by no less than 3".
- D. Refer to Division 23 Section "Vibration Controls for HVAC" for ductwork systems requiring vibration isolation hangers and supports.
- E. Hanging ductwork from roof and floor decking in steel framed buildings is prohibited. All equipment shall be hung from building steel structural system (e.g. steel beams and joists).

1. Ductwork shall be supported directly from the building's steel beams or from miscellaneous structural steel provided by the Division 23 Contractor bearing on steel beams.
 2. Loads supported by steel bar joists exceeding 100 lbs. shall be located at the joist panel points, and shall not impose an eccentric load (twisting moment). Provide supplemental steel and align direct hanger connections to the joists with the joist centerline. Connect to the upper chord of the joist wherever it is possible to do so.
 3. Supplemental steel deflections shall be limited to length/180 of the span.
- F. Steel Cable Hanger Systems Applications and Installation: Comply with all recommendations of the cable system manufacturer. Comply with all restrictions on the use of the system imposed by the SMACNA Testing and Research Institute to ensure full conformance with SMACNA standards and recommendations. System installers shall be site-trained in the use of the materials and tools by a manufacturer's representative prior to installing materials.
1. Use only on ducts with bare metal as the exterior, finished surface (e.g. uninsulated ducts, double wall ducts, and lined ducts).
 - a. Exception: Cable hanger systems may be used on ducts with exterior insulation when used as hangers for a channel trapeze support.
 2. Select cables and end connectors so that actual loads do not exceed 1/4 of the hanger system failure load. For cables hung at angles other than vertical, apply the required de-rating factor. Space hangers no more than 12 feet apart. Confirm engagement of cable locks prior to apply the load.
 3. Apply stress distribution corner guards on rectangular duct to prevent excessive cable stress and kinking or deformation of the ductwork.
 4. Material Applications:
 - a. Use galvanized steel cables on galvanized steel ducts.
 - b. Use stainless steel cables on aluminum and stainless steel ducts.
 5. Do not kink or deform cables or expose to sharp edges. Do not subject cables to a bending radius smaller than 1/4". Keep cables free of dirt, grease, and other lubricants.
 6. Do not use where the ducts are subject to dynamic loading either due to the presence of vibration or thrust force inducing equipment or asymmetrical outlet arrangements. Only use on static ducts. Restrain ducts from lateral movements using rigid hangers or by using multiple cables installed in opposing angles at a given support location.

3.7 CONNECTIONS

- A. Connect equipment with flexible connectors according to Division 23 Section "Air Duct Accessories."
- B. For branch, outlet and inlet, and terminal unit connections, comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible", 2005, unless detailed otherwise on the Drawings.

- C. Make ductwork connections to curb-mounted rooftop equipment by extending ductwork to the top of the roof curb. Provide a duct transition as required to terminate the duct at the top of the curb with a size matching that of the mating duct connection opening on the curb and on the equipment. Provide neoprene gasket on the mating surfaces between the duct end or curb and the equipment.

3.8 ADJUSTING

- A. Adjust volume-control dampers in ducts, outlets, and inlets to achieve design airflow.
- B. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for detailed procedures.

END OF SECTION

SECTION 233300

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.
- B. Related Sections:
 - 1. Division 23 Section "Diffusers, Registers, and Grilles" for manual volume dampers that are integral to diffusers, registers, and grilles.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Backdraft dampers
 - 2. Manual-balancing volume control dampers
 - 3. Motor operated dampers
 - 4. Single wall turning vanes and vane rails
 - 5. General duty duct-mounted access doors
 - 6. Instrument test holes
 - 7. Flexible connectors
 - 8. Duct accessory hardware
 - 9. Remote damper operators
 - 10. Louvers

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, location, and size of each field connection. Detail the following:
 - 1. Special fittings and manual-volume-damper installations.
 - 2. Louver installations. The Division 23 Contractor shall verify in the field the exact dimensions required for louvers to properly fit in and fill existing building openings formed by the General Contractor.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved. Also include locations of remote damper operators and instrument test holes for use by the Testing and Balancing Agent.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Combustion Ratings. All duct accessory materials shall be equal to or less than the combustion ratings noted below when tested in accordance with ASTM E84, UL723 and NFPA 255.
 - 1. Flame Spread Classification: < 25
 - 2. Smoke Development Rating: < 50
- B. All duct accessories shall meet or exceed the SMACNA pressure class standards for the ductwork system in which they are installed, or the specified ratings, whichever are higher.
- C. Damper pressure drop and air leakage ratings shall be based on tests and procedures performed in accordance with AMCA 500-D.

PART 2 - PRODUCTS

2.1 DAMPERS

- A. General: The following general provisions apply to all dampers, unless noted otherwise:
 - 1. Dampers shall be rated for no less than 2,000 feet per minute (fpm).
 - 2. Dampers shall be pressure rated for no less than the system pressure to which they are connected, or the specified rating herein, whichever is higher.
 - 3. Nominal damper dimensions shall match the connecting ductwork size indicated.
 - 4. Contractor shop-fabricated dampers are not acceptable. Dampers shall be factory fabricated by one of the manufacturers listed herein.
 - 5. Dampers shall have flanged or slip end connections. 'In-duct' type installations are not acceptable.
- B. Backdraft Dampers:
 - 1. Standard-Construction Backdraft Dampers: Factory made of minimum .050" extruded 6063-T5 aluminum blades supported on aluminum, stainless steel, or zinc plated steel rods (axles), in nylon or Celcon® bearings, set in minimum .060" 6065-T5 extruded aluminum frame. Blades shall be fitted with mechanically fastened extruded silicone or vinyl seals on contact edges to prevent noise. Aluminum and zinc-plated steel linkage hardware shall

installed in the side of the frame. Damper assembly shall be provided with an adjustable counter-balance device adjusted to assist closing or opening as indicated or required. Counterweight shall permit the start of opening with as little as 0.01" w.g. differential pressure.

- a. Fans and gravity ventilators equipped with backdraft dampers shall be furnished with dampers conforming to the requirements of this specification, and shall be furnished with dampers no smaller than the full size of the connecting collar.
- b. Dampers shall be suitable for up to 3" w.g. system pressure and 1,500 fpm velocity. Provide multiple dampers mulled together to form backdraft dampers with blade widths accommodating these pressure and velocity rating requirements.
- c. Static pressure drop at 1,500 fpm face velocity shall not exceed 0.25" w.g. when tested in accordance with AMCA 500D in the 24"x24" size.
- d. Dampers shall not have a leakage rate exceeding 10 cfm/sq.ft. at 1.0" w.g. differential pressure when tested in accordance with AMCA 500D in the 24"x24" size.
- e. Damper shall be TAMCO Series '7000CW' or approved equal.

C. Standard-Construction Rectangular (Manual Balancing) Volume Control Dampers:

1. Volume control dampers shall be of the factory fabricated opposed blade, multi-blade type, controlled from a single point using linkages and a manual, locking quadrant.. On insulated ducts, the quadrant shall have a minimum 2" standoff bracket (or as otherwise required to accommodate the specified insulation thickness and permit damper operation without insulation damage). Dampers shall be mounted in minimum 16 gauge roll formed galvanized steel channel frames with corner reinforcements. Blades shall be minimum 18 gauge galvanized roll-formed steel with a triple-V profile. Damper axles shall be 1/2" diameter plated steel, square or hex type, and the bearings shall be bronze or stainless steel oilite. Adjusting devices shall have locking mechanisms and shall be accessible. Damper shall be suitable for up to 2,000 fpm and 3.0" w.g. system pressure. Quadrants shall be oriented so that when the handle is parallel to the direction of airflow, the damper shall be fully open.
 - a. At the Contractor's option, for rectangular dampers no taller than 12" on systems specified with a pressure rating of 2" w.g. or less, and exposed to velocity no greater than 2,000 fpm, a single blade type damper complying with all other provisions indicated above may be provided, however the bearings (including the end bearing) are permitted to be synthetic, and the frame and blades may be as thin as 18 and 20 gauge, respectively.
2. Aluminum Rectangular Volume Control Dampers: Shall be as generally specified above for multi-blade dampers, but shall have type aluminum blades, frames, and axles. Blades and frames on dampers shall be minimum .080" thick.
 - a. Arrow Model '507', or approved equal.

D. Standard-Construction Round (Manual Balancing) Volume Control Dampers:

1. Factory fabricated, single blade, center pivoted, constructed of galvanized sheet steel, minimum 22 gauge blade and frame for diameters up to 12", and minimum 20 gauge blade and frame for diameters larger than 12". Damper shall be controlled from a single point

with a manual locking quadrant, and the opposite end shall be fitted with an end bearing support (i.e. no cantilevered dampers). On insulated ducts, the quadrant shall have a minimum 2" standoff bracket (or as otherwise required to accommodate the specified insulation thickness and permit damper operation without insulation damage). Axle shall be 1/4" square or hex shaped, plated steel, and the bearings shall be synthetic or brass. Damper shall be suitable for up to 2,000 fpm and 2.0" w.g. system pressure. Quadrants shall be oriented so that when the handle is parallel to the direction of airflow, the damper shall be fully open.

a. For systems with a specified pressure class above 2" w.g. and up to 3" w.g., the Contractor shall provide one of the following:

- 1) Provide a square, multi-blade damper as specified above with a pair of square to round transitions. The height and width of the square damper shall match the round duct diameter indicated.
- 2) Provide a round damper with a pressure rating meeting or exceeding the specified pressure class of the connected duct system.

2. Aluminum Round Volume Control Dampers: Shall be as generally specified above, but shall have type aluminum blades, frames, and axles. Blades and frames on round dampers shall be minimum .080" thick.

E. Motor Operated Dampers: Provide motor operated dampers at locations indicated on the drawings. Dampers shall bear the AMCA 511 label for air leakage. The dampers shall be of the various sizes shown and shall meet AMCA leakage 1A per AMCA 511, and shall have a leakage rate not greater than 3 CFM/sq. ft. based on a pressure differential of 1" w.g. when tested in accordance with AMCA 500D. Dampers and frames shall both be of extruded aluminum construction with airfoil type blades and plated steel or aluminum damper shafts which rotate in stainless steel bushings. The drive shaft shall be extended to the outside of the section to permit connecting of damper motors. Dampers shall be provided with flexible compression type stainless steel seals installed along the top, bottom and sides of the frame. Seals along each blade edge shall be EPDM or extruded silicone, suitable for operating temperatures of -50 to 250 degrees F., and installed in integral ribbed grooved inserts in blades.

1. Damper motors (actuators) shall be 120-volt two-position type, spring return and directly mounted to the damper shaft. Motors shall be provided with integral thermal overload protection and a manual crank override. Damper motors shall be as manufactured by Belimo, Honeywell, Siemens, or Johnson Controls.

F. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:

1. Backdraft Dampers:

- a. Air Balance Inc.
- b. Arrow United Industries, Inc.
- c. Greenheck Fan Corp.
- d. Ruskin Company
- e. Pottorff, a Div. of PCI Industries
- f. Cesco Products, Div. of Mestek Inc.
- g. TAMCO, T.A. Morrison and Co. Inc.

2. Manual Balancing Volume Control Dampers:

- a. Air Balance Inc.
- b. Louvers and Dampers, Inc.
- c. NCA Manufacturing.
- d. United McGill Corp.
- e. Ruskin Company
- f. Pottorff, a Div. of PCI Industries
- g. Cesco Products, Div. of Mestek Inc.
- h. TAMCO, T.A. Morrison and Co. Inc.

3. Motor Operated Dampers:

- a. Arrow United Industries, Inc. (Series AFD-20)
- b. Greenheck Fan Corp. (Series VCD-40)
- c. Ruskin Company. (Series CD50)
- d. Pottorff, a Div. of PCI Industries (Series CD-51/52)
- e. TAMCO, T.A. Morrison and Co. Inc. (Series 1500)

2.2 SINGLE WALL TURNING VANES AND VANE RAILS

- A. Turning vanes shall be installed at each mitered elbow of all square or rectangular ductwork, and shall be of sizes to suit ductwork. Vanes shall be set in factory-fabricated vane rails. Turning vanes and vane rails shall be aluminum, stainless steel, or galvanized steel, and shall match the ductwork material in which they are installed.
- B. Turning vanes shall be of the single wall (single-thickness) type, with hemmed ends on the upstream side, and lacking extended trailing ends. Turning vanes shall be factory- or shop-fabricated in accordance with Figure 4-3 and Figure 4-4 of the SMACNA "HVAC Duct Construction Standards, Metal and Flexible", 3rd edition (2005). Vane material shall be no less than 0.029-inch thick (22 gauge), and shall be suitable for no less than 2,500 feet per minute air velocity. Use SMACNA "Small" vanes (2" radius at 1.5" spacing) for all duct widths. For vanes longer than 36", install in multiple sections with the runners fastened together, or provide a tie rod secured to the vanes at mid-span.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Ductmate Industries, Inc.
 2. Duro Dyne Inc.
 3. C.L Ward LLC
 4. Sheet Metal Connectors Inc.

2.3 DUCT ACCESS DOORS

- A. General Duty Duct Access Doors: Furnish and install access doors and frames to permit inspection, operation and maintenance of devices concealed behind the sheetmetal work. Provide duct access doors of insulated double wall construction, not less than 24 gauge, galvanized steel. Provide doors and frames constructed of aluminum or stainless steel, in lieu of galvanized steel,

where required to match the ductwork. Insulation shall be 1-1/2 PCF fiberglass, no less than 1" thick. Where ducts are uninsulated, insulation in access doors may be omitted.

1. Light Duty Doors: Systems specified for 2" w.g. and SMACNA Seal Class B or C, or lower, shall utilize a double-cam or piano hinge-and-cam, square-framed access door. Doors may be either factory-fabricated or shop-fabricated. Doors shall be fitted with foam rubber gaskets around their entire perimeter, at both the door to frame junction, and where the frame meets the duct wall. Frames shall be secured to the duct using bend-back tabs and sheet metal screws.
 - a. Construct doors in accordance with Figure 7-2 of the SMACNA "HVAC Duct Construction Standards, Metal & Flexible" Third Edition (2005).
 - b. Sizing: Provide duct access doors no smaller than 18" x 18". Provide ducts smaller than 20" in height with access doors two (2) inches less in height than the height of the duct. In such cases, the length of the door shall be 18".
 - c. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Arrow United Industries
 - 2) Ductmate Industries
 - 3) Duro Dyne Inc.
 - 4) Flexmaster USA
 - 5) Pottorff Div. of PCI Industries
 - 6) Ruskin
 - 7) Ward Industries; a Div. of Hart and Cooley Inc.

2.4 ACCESSORY HARDWARE

- A. Fasteners and other hardware used to fasten duct accessories that penetrate duct walls shall utilize gasket-backed sealing washers.
- B. Instrument Test Holes: Cast iron, cast zinc alloy, cast bronze, or cast aluminum to suit duct material, including cap, base flange with screw holes and adhesive-backed gasket. Size (diameter) to allow insertion of pitot tube and other testing instruments, and length to suit duct insulation thickness. The cap shall screw-on, or shall use an expansion mechanism. Coordinate quantities and locations with the Testing, Adjusting and Balancing Agent.
 1. Test holes on aluminum duct shall be cast aluminum.
 2. Test holes on stainless steel duct shall be cast bronze.
 3. Screw fasteners shall be galvanized on galvanized steel ducts, and stainless steel on aluminum and stainless steel ducts.

2.5 FLEXIBLE CONNECTORS

- A. General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1. Connectors shall be suitable for a pressure range of +10 w.g. to -10 w.g.

- B. Metal-Edged Connectors: Factory fabricated with a strip of fabric 3-1/2 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized or Type 304 stainless sheet steel, or 0.032-inch-thick series 3003 aluminum sheet. Provide metal matching the connected ducts.
- C. Indoor System, Flexible Connector Fabric: Woven fiberglass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd..
 - 2. Minimum Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F.

2.6 REMOTE DAMPER OPERATORS

- A. Description: 'Bowden'-type cable system designed for remote manual (i.e. non-motorized, non-automatic) balancing damper adjustment. The actuator mechanism and guide tubing (e.g. casing or sheath) shall be constructed of stainless steel, galvanized steel, brass, or aluminum, and the cable shall be stainless steel. The controller shall consist of a self-locking work gear assembly. The regulator connected to the damper shaft shall consist of a shaft connector hub, wire stop, angle bracket, and casing coupling. The tubing and cable shall be up to 40 feet long, if required. The cable and housing shall be routed entirely outside of the airstream and compatible with manual balancing dampers specified elsewhere in this Section. Radial-type dampers furnished with the remote operator and the routing of actuator housing and cables inside the duct airstream are not acceptable.
 - 1. Unless indicated otherwise on the Drawings, locate the operator above the nearest accessible lay-in tile ceiling. Provide a mounting bracket and secure to the building structure, or to a wall or wall stud. Provide labeling that indicates which specific diffuser, grille, etc. is associated with the operator. Labeling shall reflect the final room numbers being used by the Client Agency.
 - 2. Where no accessible ceiling is located within 40 feet of the damper, provide a recessed, round wall or ceiling mounting cup for the operator. The cup shall be steel or aluminum and shall have a round stainless steel cover plate no larger than 3" in diameter. Coordinate the locations with the Architect and show on the ductwork shop drawings and coordination drawings. In this installation, the regulator connected to the damper shaft shall consist of a self-locking work gear assembly.
 - 3. Where indicated or detailed as such on the Drawings, locate the operator inside the plenum of slot diffusers with an L-shaped bracket, with access through the opening in the slot diffuser. When locating the operator, the final adjustment position of the slot diffuser pattern controller shall be considered, so that the pattern controller does not need to be moved to make adjustments to the damper.
 - 4. Furnish one (1) cable adjustment tool to the Client Agency, if the tool is proprietary.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Metropolitan Air Technology (MAT)
 - 2. Pottorff; a division of PCI Industries, Inc.
 - 3. United Enertech
 - 4. Young Regulator Company

2.7 LOUVERS

- A. General: Provide louvers where shown; of sizes, shapes, capacities and types indicated; constructed of materials and components as specified and as required for complete installation.
- B. Substrate Compatibility: Provide louvers with frames, clip angles, mounting hardware and sill styles that are compatible with adjacent substrate and that are specifically manufactured to fit into construction openings with accurate fit and adequate support, for weatherproof installation. Refer to general construction drawings and specifications for types of substrate which will contain each type of louver.
- C. Fixed Intake and Discharge Air Louvers:
1. Louvers shall be the stationary drainable blade type with a frame depth of 4 inches. Frames and blades shall be .081-inch-thick 6063-T5 extruded aluminum alloy. Blades shall be located on a 37.5- to 45-degree blade angle spaced between 3.75" to 5" on-center. Jambs shall incorporate vertical downspouts. Birdscreens shall be provided on the interior of the louver and shall consist of 1/2" galvanized steel mesh with an extruded aluminum frame. Expanded metal is not acceptable. Screens shall be mounted to the frame face and be removable for cleaning. Screens may be omitted for those sections requiring blank off panels.
 2. Factory Finish: Louvers shall receive factory applied, 50% Kynar 500 /Hylar 5000 coating. The finish shall be applied at 1.2 mils (30µm) total dry film thickness in accordance with AAMA 2604-02 Section 4.2 and 4.3. The color shall be custom as selected by the Architect from the manufacturer's standard color charts, with no less than 30 standard offerings. The finish shall have a minimum 5-year warranty against peeling, color fade, or chalking.
 3. Performance: Louvers shall intake air at 1000 feet per minute (FPM) free area velocity with less than .21 inch w.g. pressure drop, and with water penetration of less than .01 ounces of water per square foot (i.e. the point of water penetration as defined by AMCA Publication 511 shall be no less than 1,000 FPM free area velocity). Test criteria shall be based on a 48" square sample with a minimum 45 percent free area. Louvers shall bear the AMCA Certified Ratings Seal for both Air Performance and Water Penetration, with testing performed in accordance with AMCA Publication 511.
- D. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Warming & Ventilating Inc. (Model LE-21).
 2. Greenheck Corp. (Model ESD-403 or ESD-435)
 3. Louvers & Dampers, Inc. (Model IEL-4-304)
 4. Ruskin (Model ELF-445DX)
 5. Arrow United Industries (Model EA-415-D)
 6. Airolite (Model K6774)
 7. Pottorff (Model EFD-445).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details shown in SMACNA's "HVAC Duct Construction Standards, Metal and Flexible", 3rd Edition (2005), except as elsewhere modified by the project Specifications or Drawings.
- B. Install duct accessories of materials suited to duct materials. Unless otherwise noted, use galvanized-steel or aluminum accessories in galvanized-steel ducts, stainless-steel accessories in stainless-steel ducts, and aluminum or stainless steel accessories in aluminum ducts.
- C. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
- D. Dampers shall be selected so their static pressure ratings are no less than that specified for the connecting ductwork, and the damper velocity rating is no less than the design velocity of the duct section in which each damper is installed.
- E. Install remote cable damper operators to provide for remote manual volume damper adjustment where the dampers are not easily accessible through a lay-in tile ceiling.
- F. Instrument Test Holes: Provide test holes at fan inlets and outlets, in locations as required to measure pressure drops across each item in the system (e.g. outside air louvers, filters, fans, coils, intermediate points in duct runs, etc), and elsewhere on ductwork as indicated or required for airflow testing, measuring, and balancing. Coordinate with the Testing and Balancing Agent performing the work of Division 23 Section "Testing Adjusting and Balancing for HVAC", and provide the quantity and size of test holes where directed by the Agent.
- G. Set dampers to fully open position before testing, adjusting, and balancing.
- H. Turning Vanes: Provide single wall turning vanes in all mitered duct elbows, except for transfer ducts and other clean air ducts with design velocities less than 750 feet per minute. Turning vanes and vane rails shall be aluminum, stainless steel, or galvanized steel, and shall match the ductwork material in which they are installed.
- I. General Duty Duct Access Door Installation: Install duct access doors on sides or bottom of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment.
 - 1. Where rectangular access doors are installed on round ducts constructed for 2" w.g. pressure class and less, provide a rectangular tap fitting to receive the rectangular door.
 - 2. Install doors at the following locations:
 - a. Both upstream and downstream of duct coils.
 - b. Downstream of VAV terminal unit coils.
 - c. Upstream from duct filters.
 - d. At outdoor-air intake plenums. Only side mounting is permitted.
 - e. At duct drain pans for duct humidifiers. Only side mounting is permitted.
 - f. Downstream from control dampers and backdraft dampers

- g. On discharge ductwork connected to equipment (in-line and cabinet fans, fan coil units, ducted cabinet heaters, blower coil units, water source heat pumps, ducted unit ventilators, make up air units, air handling units, etc.)
 - 1) All fans and fan-containing equipment shall have a minimum of one access door on the associated ductwork.
 - h. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links.
 - i. At each change in direction and at maximum 50-foot spacing.
 - j. Upstream from turning vanes.
 - k. Upstream of airflow measuring stations.
 - l. Upstream or downstream of other control devices requiring inspection.
 - m. Elsewhere as indicated or shown.
- J. Flexible Connector Installation: Install flexible connectors to connect ducts to vibrating equipment. Transverse connections to ducts shall be made as specified in Division 23 Section "Ductwork" for ductwork transverse joints. Connector fabric shall not be overly compressed nor placed under tension when the fan is off or when operating at maximum speed and pressure. Provide thrust restraints where required.
- 1. Flexible connectors shall be omitted on ductwork connections to vibrating equipment in the following cases:
 - a. The equipment is rigidly supported or anchored, and is provided with internal flexible connector(s) and vibration isolators meeting the requirements of Division 23 Section "Vibration Controls for HVAC".
- K. Provide thrust restraints for fans as specified in Division 23 Section "Vibration Controls for HVAC".
- L. Louvers: The .1 Contractor shall furnish and install wall louvers in openings. The .1 contractor shall furnish and install structural lintels and wall openings, The .1 Contractor shall furnish and install clip angles, mounting hardware, flashing and frames suitable for the type of construction where louvers are installed.
- 1. Seal around perimeter of louver frame with elastomeric joint sealants. Use Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant of color selected by the Architect. Installations shall be completely watertight.

3.2 ADJUSTING

- A. Adjust duct accessories for proper settings.
- B. Adjust backdraft damper counter-balance devices to assist closing or opening as indicated or required.
- C. Adjust fire dampers for proper action.

- D. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION

SECTION 233400

HVAC FANS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.
- B. Related Division 23 Sections include the following:
 - 1. "Vibration Controls for HVAC" for requirements for fan vibration isolators and vibration bases.
 - 2. "Common Motor Requirements for HVAC Equipment" for general motor requirements.
 - 3. "Air Duct Accessories" for dampers and flexible duct connectors.

1.2 SUMMARY

- A. This Section includes the following types of fans:
 - 1. Square inline centrifugal fans

1.3 ACTION SUBMITTALS

- A. Product Data: Including specialties, accessories, and the following:
 - 1. Certified full range fan performance curves with system operating conditions indicated.
 - a. Fans shall be selected for sea level unless noted otherwise on the Drawings.
 - b. Fans shall be selected for 70 degrees F. air, unless noted otherwise on the Drawings.
 - 2. Certified fan sound power ratings.
 - 3. Motor ratings and electrical characteristics plus motor and fan accessories.
 - 4. Materials thicknesses and finishes.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Fan speed controllers.
- B. Shop Drawings: From manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location and size of field connections.
- C. Wiring diagrams that detail power, signal, and control wiring. Differentiate between manufacturer-installed wiring and field- installed wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For fans, for inclusion in Operating and Maintenance Manuals.
 - 1. Data shall include detailed instructions for bearing maintenance, including lubrication intervals, lubricant type, and procedures.

1.6 QUALITY ASSURANCE

- A. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal. All fans shall be AMCA rated for both sound and performance.
 - 1. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Comply with AMCA 311 and label fans with the AMCA-Certified Ratings Seal.
 - 2. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Comply with AMCA 211 and label fans with the AMCA-Certified Ratings Seal.
 - 3. Fans, except for power roof and wall ventilators, wall mounted propeller fans, and fans with motors smaller than 5 HP, shall have a fan efficiency grade (FEG) of no less than 67, when tested in accordance with AMCA 205 "Energy Efficiency Classification for Fans", and shall have a design point efficiency within 15 percentage points of the maximum total efficiency, in compliance with the 2015 International Energy Conservation Code.
- B. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- C. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code".
- D. Bearing fatigue life / ratings and the term "air handling quality" shall be as defined by the American Bearing Manufacturers Association (AMBA).
- E. UL Standards: All fans shall be listed to UL 705.
- F. Fans specified or scheduled on the Drawings to have spark resistant construction shall conform to the construction type specified as defined by AMCA Standard 99-0401, "Classifications for Spark Resistant Construction."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Lift and support units with the manufacturer's designated lifting or supporting points.

- B. Deliver fan units as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.
- C. While in storage and after installation but before system startup, when recommended by the fan manufacturer, inspect and maintain fans once per month. Keep a record of inspection and maintenance performed. At each inspection, rotate the fan wheels by hand to re-distribute lubricant and alter the static bearing load.

1.8 SEQUENCING, SCHEDULING, AND COORDINATION

- A. Coordinate the installation of equipment supports.
- B. Coordinate the size and location of structural steel support and framing members.
- C. Coordinate fan motor size, starter type, local disconnecting means, voltage, and phase with the Division 26 Contractor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1. Square Inline Centrifugal Fans:
 - a. Aerovent (Series SCDD/SCBD)
 - b. Cook (Loren) Co. (Series SQN-D/SQN-B).
 - c. Greenheck Fan Corp. (Series SQ/BSQ) - (Basis of Design)
 - d. Twin City Fan & Blower (Series BSI/DSI).

2.2 SQUARE INLINE CENTRIFUGAL FANS

- A. General: Provide centrifugal, square, in-line type fans at locations indicated on the Drawings. Provide accessories specified herein and indicated or scheduled on the Drawings. Fans shall be direct-driven, as scheduled on the Drawings.
- B. Where indicated on the Drawings, the fans shall be classified for "Type B Spark Resistant Construction" conforming to AMCA 99-401.
- C. Fan Housing: Square design constructed of heavy gauge galvanized steel with duct collars and minimum 1/2" thick internal coated fiberglass insulation. Fan housing shall be equipped with removable service panels for access to the motor, drives, and fan wheel. Fan design shall permit single or dual side discharge arrangements, and installation in the horizontal or vertical.
- D. Fan Wheel: Aluminum backward inclined single inlet / single width centrifugal type, statically and dynamically balanced and overlapping a spun inlet venturi.

- E. Motor: Isolated from the airstream. Provide direct drive units with a motor cover. Motor shall be heavy duty with permanently lubricated sealed ball bearings. Wheel shaft shall be ground and polished and mounted in permanently sealed pillow block bearings. Bearings shall be selected for a minimum (L10) life in excess of 100,000 hours at maximum cataloged operating speeds.
 - 1. Single phase direct drive units shall have electrically commutated (EC) type motors with:
 - a. Integral speed adjustment dial for use by the TAB Agent during balancing.
- F. Electrical: Flexible wiring leads shall be provided from the fan motor to an external mounted junction box and NEMA 1 disconnect switch. Mount the switch on the fan housing unless explicitly indicated otherwise on the Drawings.

2.3 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances, housekeeping pads, and other conditions affecting performance of fans.
- B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Install fans level and plumb, in accordance with manufacturer's written instructions.
- B. Install unit to permit access for maintenance.
- C. Install parts and accessories shipped loose.
- D. Support suspended fans (other than ceiling mounted fans and circulation fans) from structure using threaded steel rods and spring vibration isolator hangers.
- E. Provide vibration isolation for all suspended fans, base-mounted fans, fans supported on rooftop support rails, and where indicated on the Drawings.
 - 1. Isolators shall may be furnished by the fan manufacturer, however the isolators shall comply with the requirements for vibration-control devices as specified in Division 23 Section "Vibration Controls for HVAC."

3.3 CONNECTIONS

- A. Duct installations and connections are specified in Division 23 Section "Ductwork".
- B. Provide flexible duct connectors on duct connections to fans as specified in Division 23 Section "Air Duct Accessories", except where specifically prohibited.
- C. Install ducts adjacent to power ventilators to allow service and maintenance.
- D. Connect wiring and ground equipment according to applicable Division 26 provisions.

3.4 ADJUSTING AND CLEANING

- A. Adjust damper linkages for proper damper operation.
- B. For direct drive fans, set VFD operating speed or adjust the ECM motor dial or speed controller as required to achieve design airflow.
- C. Lubricate bearings.
- D. Clean unit interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.
- E. For coated, or paint finished fans, inspect the coating or paint finish for chips, scratches, and abrasions of the finish. Repair damaged finish as recommended by the fan manufacturer using a coating equal in performance to, with an equal or greater dry film thickness as, the factory-applied finish.

3.5 FIELD QUALITY CONTROL

- A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:
 - 1. Remove shipping blocking and bracing.
 - 2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
 - 3. Perform cleaning and adjusting specified in this Section.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearings operations.
 - 5. Lubricate bearings, and other moving parts with factory-recommended lubricants.
 - 6. Disable automatic temperature control operators.
- B. Starting procedures for fans:
 - 1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
 - 2. Measure and record motor electrical values for voltage and amperage.
- C. Shut unit down and reconnect automatic temperature control operators.

- D. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for procedures for fan testing, adjusting, and balancing.

3.6 DEMONSTRATION

- A. Demonstration Services: Train Client Agency's maintenance personnel on the following:
 - 1. Procedures and schedules related to start-up and shutdown, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
 - 2. Familiarization with contents of Operating and Maintenance Manuals.
- B. Schedule training with at least 7 days' advance notice.

END OF SECTION

SECTION 233713

DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.
- B. Related Sections include the following:
 - 1. Division 23 Section "Air Duct Accessories" for:
 - a. Manual balancing dampers that are not integral to diffusers, registers, and grilles.
 - b. Louvers.
 - 2. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for balancing diffusers, registers, and grilles. That Section also includes requirements for airflow pattern adjustments.

1.2 SUMMARY

- A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.

1.3 ACTION SUBMITTALS

- A. Diffuser Register and Grille Product Data: For each model indicated, include the following:
 - 1. Data Sheet: For each type of air outlet and inlet, and accessory furnished; indicate construction, finish, and mounting details.
 - 2. Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet.
 - 3. Schedule of diffusers, registers, and grilles indicating drawing designation, room location, quantity, model number, size, and accessories furnished.
 - 4. Assembly Drawing: For each type of air outlet and inlet; indicate materials and methods of assembly of components.
 - 5. Samples for Color Selection: For diffusers with factory finishes other than white.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans and wall elevations drawn to scale to show locations and coordination of diffusers, registers, and grilles with other items installed in ceilings and walls.

1.5 QUALITY ASSURANCE

- A. NFPA Compliance: Install diffusers, registers, and grilles according to NFPA 90A, "Standard for the Installation of Air-Conditioning and Ventilating Systems."
- B. Diffusers and grilles shall be tested in accordance with ANSI/ASHRAE Standard 70-2006.

PART 2 - PRODUCTS

2.1 REGISTERS AND GRILLES

- A. General: Except as otherwise indicated, provide manufacturer's standard registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as specified and as required for complete installation.
- B. Product Names: Where specific product names are listed in this Section, but specific product names are also indicated on the Drawings for diffusers, registers, and grilles of a generally similar type, the Drawing model name indication shall take precedence.
- C. Performance: Provide registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop and noise criteria ratings for each size device and listed in manufacturer's current data.
- D. Ceiling Compatibility: Provide registers and grilles with border styles and accessory panels and frames that are compatible with adjacent wall and ceiling systems and that are specifically manufactured to fit into wall and ceiling construction with accurate fit and adequate support. Refer to general construction Drawings and specifications for types of wall and ceiling construction which will contain each type of register and grille.
 - 1. Where specified diffusers are smaller than the ceiling system module in which the diffusers are intended to be placed, provide mounting panels of appropriate dimensions to set the diffusers and fill in an entire ceiling system module, and to center the diffuser within the mounting panel. The mounting panel shall have a material of construction and finish matching that of the diffuser.
- E. Paint Finishes: Where painted finishes are specified, the color shall be factory standard off-white, unless indicated otherwise on the Drawings.
- F. Exhaust, Relief, Transfer and Return Air Bar Grilles and Registers:
 - 1. Grilles and registers shall be securely attached and supported from associated ductwork or, where not duct connected, shall be attached and supported from the building structural system. Grilles and registers shall not be supported by ceilings of any type.
 - 2. Grilles and register faces shall have baked enamel or anodic acrylic factory painted finishes.
 - 3. Generally, grilles shall be fabricated from steel and have horizontal steel louvers, spaced 3/4" on centers and fixed at 35 degrees deflection.

4. Grilles and registers installed in wet area locations, showers, locker rooms, kitchens, pool rooms, and where installed in aluminum duct systems shall be as specified above, except construction shall be all-aluminum. Also provide aluminum grilles elsewhere explicitly indicated on the Drawings.

G. Supply Air Bar Grilles and Registers:

1. Provide supply air registers consisting of double deflection arrangement with individually adjustable vertical front blades and individually adjustable horizontal back blades with frames. Blades shall be solid (not hollow). Supply registers shall be finished as specified above for exhaust and return grilles and registers.
2. Supply registers shall be constructed of aluminum.

H. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:

1. Exhaust, Relief, Transfer and Return Air Bar Grilles and Registers:

- a. Price Industries. (Series 620)
- b. Krueger HVAC
- c. Titus
- d. Tuttle and Bailey

2. Supply Air Bar Grilles and Registers:

- a. Price Industries. (Series 630)
- b. Krueger HVAC
- c. Titus

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb, according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of the panel. Where architectural features or other items conflict with installation, notify the Architect for a determination of final location. Support grilles registers and diffusers

located in ceilings from overhead building structural steel or from ductwork. Do not support from ceiling system.

- C. Install diffusers, registers, and grilles with airtight connection to ducts and to allow service and maintenance of dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC".

3.4 CLEANING

- A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

END OF SECTION

SECTION 235100

GAS VENTS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes the following types of manufactured gas appliance venting materials:
 - 1. Double-wall special gas vents
 - 2. Polypropylene gas vents

1.3 DEFINITIONS

- A. AL 29-4C: A superferritic stainless steel alloy designed by Allegheny Ludlum for extreme resistance to chloride ion pitting, crevice corrosion and stress corrosion cracking. Equivalent material made by other manufacturers may be identified by the UNS designator S44735.
- B. Category I Appliance: An appliance which operates with a non-positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the appliance.
- C. Category II Appliance: An appliance which operates with a non-positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the appliance.
- D. Category III Appliance: An appliance that operates with a positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the appliance.
- E. Category IV Appliance: An appliance that operates with a positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the appliance.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
- B. Shop Drawings: Show fabrication and installation details for venting system. Include plans, elevations, sections, details, and attachments to other Work. Detail assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, hangers, and location and size of each field connection.

1. Include information that clearly demonstrates that the configuration, length, number of fittings, and sizing is acceptable to the heating appliance manufacturer and is full compliance with the appliance's UL listing and the appliance manufacturer's recommendations.

1.5 INFORMATIONAL SUBMITTALS

- A. Certified Sizing Calculations: The gas fired equipment appliance manufacturer shall furnish all required flow and backpressure information to the venting system manufacturer, including the flow characteristics of any accessories, such as vent connectors or outdoor terminal hoods, etc. Then sizing calculations shall be performed by the venting system manufacturer based on the shop drawing layout of the system.
 1. Include a letter from the gas fired equipment manufacturer certifying that the venting system sizing and layout meets all of the manufacturers requirements.

1.6 SPECIAL WARRANTY

- A. Special Double Wall Gas Vents: The vent system manufacturer shall provide a material and labor warranty that the products are free from defects in material and workmanship, or UV degradation, for a minimum of 15 years.
- B. Polypropylene Gas Vents: The vent system manufacturer shall provide a material and labor warranty that the products are free from defects in material and workmanship for a minimum of 10 years.

1.7 QUALITY ASSURANCE

- A. Source Limitations: Obtain vent system components through one source from a single manufacturer. The entire flue system from the appliance outlet to the termination point, including all accessories, except as noted, shall be from one manufacturer.
- B. Appliance Compatibility: The heating appliance manufacturer shall confirm that the product type, configuration, length, number of fittings, and sizing is acceptable to the heating appliance manufacturer, and is full compliance with the appliance's UL listing and the appliance manufacturer's recommendations.
 1. The Contractor shall verify compatibility during the bidding period. No extras will be due as a result of the Contractor failing to coordinate his bid.
- C. UL / ULC Compliance: Venting systems shall be listed, and applied in accordance with their listing.
- D. Vent System Installation: Comply with NFPA 54 / ANSI Z223.1, the National Fuel Gas Code.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
1. Special Double-Wall Gas Vents:
 - a. CaptiveAire Systems - "2V Type BH"
 - b. DuraVent Inc. - "DuraSeal"
 - c. Heat-Fab, Inc./ Selkirk - "Saf-T-Vent CI Plus"
 - d. Enervex - "PowerStack EPS"
 - e. Jeremias Inc. - "DWKL"
 - f. Metal-Fab, Inc. - "Corr/Guard"
 - g. Security Chimneys - "Secure Seal"
 - h. The Schebler Co. - "eVent"
 - i. Z-Flex, Novaflex Inc. - "Z-Vent Commercial Special Gas Vent"
 2. Polypropylene Gas Vents:
 - a. Centrotherm Eco Systems - "InnoFlue SW Commercial"
 - b. DuraVent Inc. - "PolyPro"
 - c. Heat-Fab Inc. / Selkirk - "Polyflue"
 - d. Z-Flex, Novaflex Inc. - "Z-Dens"

2.2 DOUBLE-WALL SPECIAL GAS VENTS

- A. Description: UL-1738 listed double-wall metal venting system, in sizes from 3" to 32", tested according to UL 1738 and rated for an operating temperature of 480 deg. F. and a 550 deg. F. maximum flue gas temperature, with positive or negative flue pressure complying with NFPA 211. Provide pipe, vent terminal, supports, drain and test port fittings, appliance connectors, thimble, condensate trap, sealant, and all other required accessories. System shall be suitable for use with Category II, III, and IV heating equipment (as defined by NFPA 54 / ANSI Z223.1) where accepted by the equipment manufacturer. The system shall be installed and arranged to compensate for all flue gas induced thermal expansion.
- B. Construction: Inner and outer metal shells separated by minimum 1-inch of insulating air space, with positive sealing joints.
- C. Required Clearance to Combustibles: No more than 6", concealed or unconcealed, horizontal or vertical, throughout the size range offered, with an operating temperature of 480 deg. F. / maximum flue gas temperature of 550 deg F.
- D. Inner Wall: ASTM A 959, Type AL29-4C super-ferritic stainless steel, or Type 316L-PCM (Purified Chromium and Molybdenum) stainless steel, or Type 444 stainless steel, with minimum thicknesses as follows:
1. 0.015" for sizes up to 8"

2. 0.020" for sizes 10" to 16"
 3. 0.025" for sizes 18" to 24"
 4. 0.035" for sizes 26" and larger.
- E. Outer Jacket: Type 304, 316, or 430 Stainless Steel or Aluminum-coated steel, minimum 0.018" thick.
- F. Accessories: Appliance connectors, tees, elbows, increasers, vent termination, drain fittings, adjustable roof base flashing, wall flashing, storm collar counterflashing, support assembly, thimbles, firestop spacers, test ports, and fasteners; fabricated of similar materials and designs as vent-pipe straight sections.
1. Support materials shall be either 300 or 400 series stainless steel.
 2. Variable / adjustable length sections are not permitted unless they are UL listed to the same leakage, temperature, and pressure ratings as the rest of the venting system.
 3. Termination: Stack cap designed to exclude 90 percent of rainfall, unless such a cap is not recommended by the gas appliance manufacturer.
 4. Test Port: 1 inch diameter coupling, plugged. Locate on individual stack serving each appliance. Locate in an accessible location in a non-turbulent zone.

2.3 POLYPROPYLENE GAS VENTS

- A. At the Contractor's option, and subject to the project requirements and the requirements of the appliance manufacturer, polypropylene vents may be used in lieu of the UL-1738 special double wall stainless steel gas venting herein specified.
1. If the use of this venting material requires limiting the supply water temperature setpoint heating output setpoint at the boilers / gas fired appliance to a value lower than the design temperature of the system, as evidenced by the schedules on the Drawings (e.g. entering water temperature scheduled for coils, etc.), then the Contractor shall not include any cost savings for using material in his/her bid price, and special double wall gas vents shall be provided instead.
 2. The Contractor shall provide a warning sign on or immediately adjacent to the boiler / appliance controllers where the supply water temperature adjustment can be made indicating the maximum safe supply water temperature setpoint for the venting material installed, as recommended by the boiler manufacturer.
- B. Description: UL 1738 listed or ULC S636 listed as a Type BH - Class IIC gas venting system rated for a continuous maximum flue gas temperature of 230 deg. F., with positive flue pressure as high as 15" w.c. Sizes shall be available from 2" to 12" inner diameter. Provide pipe, vent terminal, supports, drain and test port fittings, appliance connectors, thimble, condensate trap, sealant, and all other required accessories. System shall be suitable for use with Category II and IV heating equipment (as defined by NFPA 54 / ANSI Z223.1) where accepted by the equipment manufacturer. The system shall be installed and arranged to compensate for all flue gas induced thermal expansion.
- C. Construction: Single wall, 3mm thick polypropylene, with EPDM or Viton gasketed joints. Gasket material shall be approved by the appliance manufacturer. Polymer for portions of the system installed outdoors shall be permanently UV-stabilized and fully suitable for exterior use without additional protection or applied coatings.

- D. Required Clearance to Combustibles: Zero, concealed or unconcealed, horizontal or vertical, throughout the size range offered, with a sustained maximum flue gas temperature of 230 deg F.
- E. Accessories: Appliance connectors, tees, elbows, increasers, vent termination, drain fittings, roof base cone flashing, wall flashing, storm collar counter-flashing, support assembly, thimbles, firestop spacers, and fasteners; fabricated of similar materials and designs as vent-pipe straight sections.
 - 1. Termination: Stack cap designed to exclude 90 percent of rainfall, unless such a cap is not recommended by the gas appliance manufacturer.
 - 2. Variable / adjustable length sections are not permitted unless they are UL listed to the same leakage, temperature, and pressure ratings as the rest of the venting system.
 - 3. Test Port: 1 inch diameter coupling, plugged. Locate on individual stack serving each appliance. Locate in an accessible location in a non-turbulent zone.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF MANUFACTURED VENTS

- A. Entire vent system from the appliance outlet to the termination point, including accessories shall be from one manufacturer, except where explicitly noted otherwise.
- B. Provide all required accessories and fittings for a complete and functional installation in compliance with the venting system and gas appliance manufacturer's requirements and recommendations.
- C. Install according to manufacturer's written instructions. Locate to comply with minimum clearances from combustibles.
- D. Assemble and seal joints according to manufacturer's written installation instructions, using sealants and other materials recommended by manufacturer.
- E. Provide ventilated thimbles for indoor wall penetrations.
- F. Roof penetrations shall be suitable for the specified roof construction, shall maintain the roof warranty, and shall comply with the manufacturer's installation instructions. Provide a ventilated roof thimble to provide required clearances.
- G. The vertical stack termination shall be no less than three (3) feet above the roof penetration, or no less than two (2) feet above any portion of the building within ten (10) feet of the stack penetration, or the height indicated on the Drawings, or the height required by the gas fired equipment manufacturer, whichever of these four (4) criteria is the highest.

1. Also provide the minimum required clearance to the combustion air intake as recommended by the gas fired equipment manufacturer.
 2. Wind Restraints: Where the height of the stack exceeds the venting manufacturer's recommendations for a moment-supported stack at the roof structure, provide a system of adjustable guy wires or a system of rigid wind restraints / supports in accordance with the manufacturer's recommendations.
 - a. If guy wires are employed, provide no less four (4) guy wires, and provide a guy ring near the top of the stack and at intervals required by the venting system manufacturer. The maximum angle between guy wires as viewed from above shall be 120 degrees, and the guy wires shall be angled no less than 30 degrees from vertical. Provide galvanized steel anchors secured to the roof structural system with base- and counter-flashing. Guy wires shall be minimum 1/8-inch diameter 7x19 steel aircraft cable with a minimum tensile breaking strength of 2,000 lbs. The cable shall be stainless steel or galvanized steel with a plastic coating. Furnish double-eye turnbuckles for tensioning, cable clamps (clips), thimbles to prevent kinking at securement points, and eyebolts for attachment to the roof anchors. All accessory materials shall be hot dipped galvanized or stainless steel, and shall be selected to match the specified breaking strength of the cable.
- H. Support vents at intervals recommended by the manufacturer to support weight of vent and all accessories, without exceeding loading of appliances. Support vents from the building structure. Supporting from metal decking is not permitted.
 - I. Except for when drip tees are employed, all horizontal and vertical offsets shall be made with 45-degree elbows.
 - J. Entrances to vertical runs shall be made with a boot-type branch tee, or with a 45 deg. branch fitting combined with a 45 deg. elbow. The end of the branch tee at the base of the riser shall be provided with a drain fitting. Connect stainless steel tubing with a ball valves to the drain connection. Extend tubing to nearest floor or funnel drain.
 - K. Install the venting system so as to account for expansion and contraction. Provide expansion sections and spring hangers and supports.
 1. Inspect vents and joints for integrity immediately after system startup to full temperature. Complete tests and inspections prior to concealment.
 - L. Lap joints in direction of flow.
 - M. Slope vents a with positive slope up and away from the fuel-fired equipment.
- 3.3 CLEANING
- A. After completing system installation, including terminals, inspect exposed finishes. Repair damaged finish to match original finish.
 - B. Clean vents internally, during and on completion of installation, to remove dust and debris.

- C. Provide temporary closures at ends of vents that are not completed or connected to equipment.

END OF SECTION

SECTION 235217.11

STAINLESS STEEL FIRE TUBE CONDENSING BOILERS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.
- B. Related Sections include the following:
 - 1. Division 23 Section "Gas Vents".
 - 2. Division 23 Section, "Water Treatment for Closed-Loop Hydronic Systems".

1.2 SUMMARY

- A. Section includes wall mounted, gas-fired, stainless steel fire-tube condensing boilers with required trim and accessories for generating heating hot water.
- B. The Contractor shall complete and submit an "*Intent to Install Boiler*" form to the Pennsylvania Department of Labor and Industry, Boiler Division. The Contractor shall be responsible for the fee for the submission.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for boilers.
 - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, and required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
 - 4. Plans and elevations and details of boiler venting and combustion air piping.
 - a. Verification of Venting System Compatibility: The boiler manufacturer shall confirm in writing that the product type, configuration, length, number of fittings,

and sizing is acceptable to the heating appliance manufacturer, and is full compliance with the appliance's UL listing and the appliance manufacturer's recommendations. Coordinate with the requirements of Division 23 Section "Gas Vents."

1.4 INFORMATIONAL SUBMITTALS

- A. Certified Sizing Calculations: Boiler manufacturer shall certify venting system sizing calculations. The boiler manufacturer shall furnish the exact operating characteristics and requirements of the boiler equipment to the venting system factory representative so that vent sizing calculations may be performed.
- B. Source Quality-Control Reports: Manufacturer shall supply copies of the Test Fire Report, including fuel/air settings and combustion test results.
- C. Field Test Reports: This shall include both startup test reports and functional test reports. Indicate and interpret test results for compliance with performance requirements. Submit completed manufacturer's startup checklists.
- D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals. Include parts list, maintenance guide, and wiring diagrams for each boiler.

1.6 CHEMICAL TREATMENT SYSTEMS SUMMARY

- A. Provide all labor, material and equipment for cleaning and flushing piping systems and providing water treatment chemicals and miscellaneous equipment for piping systems.
 - 1. All work described herein equally applies to any existing heating hot water system piping as it does to new hydronic piping systems and components and equipment.
 - 2. Work shall include evaluating the special requirements of the stainless steel boilers and ensuring that the system conditions strictly comply with all recommendations of the boiler manufacturer.
 - a. Ensure that the chosen treatment is appropriate and certified by the boiler manufacturer.
 - b. The chemical treatment manufacturer shall furnish a guarantee that the treatment, when applied according to the manufacturer's recommendations, will not cause harm to the boiler, pumps, piping, and other components of the hydronic boiler system.
 - c. Initial Fill Requirements:
 - 1) Artificial Softness – Do NOT use artificially softened water to fill the system. Artificial softening agents generally use salt, which creates a chloride water chemistry, a major contributor to the corrosion of the types of metals used in

- hydronic systems. Elevated salt levels also contribute to higher conductivity levels, another undesirable characteristic in hydronic systems.
- 2) Provide naturally soft water (not DI or RO water) for the filling of the system if the on-site water is not suitable for the system. Make up water pH shall be between 7.5 and 8.8.

d. Achieve the following system water quality requirements for the *Basis of Design* boiler:

- 1) Total Hardness – Less than 200 ppm (11.7grains/gallon).
- 2) Chloride - Less than 125 ppm.
- 3) Conductivity – Less than 3000 μ S.
- 4) pH - within 8.0 and 9.5.
- 5) Oxygen: less than 250 ppb (parts per billion).
- 6) Total Iron / Copper: less than 5 ppm.
- 7) Total Dissolved Solids - preferably less than 500 ppm, but a requirement of less than 1000 ppm.

1.7 QUALITY ASSURANCE

- A. The equipment shall fit within the allocated space, leaving ample allowance for maintenance and inspection.
- B. NFPA Compliance: Install gas-fired boilers in accordance with NFPA code 54 “National Fuel Gas Code”.
- C. Boilers shall be fully factory test fired prior to shipment.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Listing and labeling: Provide products specified in this Section that are listed and labeled.
 1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- F. UL Compliance: Test boilers for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- G. The boiler manufacturer shall be an ASME certified company, and shall have a current ASME certificate.
- H. ASME Compliance: Fabricate and stamp boilers according to ASME Boiler and Pressure Vessel Code, Section IV, "Heating Boilers."
 1. The boiler shall bear the ASME "H" stamp for no less than 30 psi working pressure and shall be National Board listed.

- I. Boilers, including gas train and controls, shall be listed as complying with ANSI Z21.13 / CSA 4.9, Standard for Gas-Fired Low Pressure Steam and Hot Water Boilers.
- J. Boiler shall be AHRI listed and certified.

1.8 WARRANTY

- A. General Warranty: The boiler vendor/service company, through the Contactor, shall provide one (1) year of warranty parts and labor.

1.9 EXTRA MATERIALS

- A. Provide enough neutralizing agent for one full refill of all neutralizing traps provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS AND BIDDING

- A. The Bidding Contractor and Boiler Manufacturer Representatives shall verify during the bidding process, that the boiler being proposed for use as the basis for the Contractor's bid price meets and accommodates all of the above-listed performance and operating parameters and system configuration requirements, in addition to those indicated and scheduled on the Drawings.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1. Lochinvar "Knight" (Fire Tube)
 - 2. Triangle Tube "Prestige Solo"
 - 3. Weil-McLain "Evergreen"

NOTE: All boilers other than those indicated to be the '*Basis of Design*' shall be considered 'alternate boilers' for purposes of this specification, including the paragraph below.

- C. It is the full burden of the Contractor to include in his bid the costs associated with making all required modifications to the design and installation, at no additional cost beyond that accounted for in the bid price, in order to accommodate the specific installation requirements of the alternate boiler, including those affecting the work of other Divisions. The design modifications shall meet with the approval of the Architect and Engineer. The Architect and Engineer are the sole determiners of acceptability.

2.2 FORCED-DRAFT, STAINLESS STEEL FIRE-TUBE CONDENSING BOILERS

- A. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, including insulated jacket; flue-gas vent; combustion-air intake connections (fully sealed combustion); water supply, return, and condensate drain connections; and controls. Water-heating service only.

- B. Water Connections for Wall Mounted Boilers: Hydronic supply and return connections shall be made on the bottom of the boiler.
- C. Mounting: Provide a casing frame for securing boiler to the mechanical room wall.
- D. Combustion chamber: Sealed and completely enclosed, and independent of the outer jacket assembly. A burner/flame observation port shall be provided for observing the burner flame and combustion chamber.
- E. Heat Exchanger: Type 316L or 439LT (S43932) stainless steel, fully welded, down firing design.
 - 1. Condensate Collection Basin: Stainless steel or high temperature polymer, with condensate trap.
- F. Pressure Vessel: Carbon or stainless steel with welded heads and tube connections, single pass counter-flow design (i.e. up-flow).
- G. Return Water Temperature Rating: The boiler shall be capable of receiving return water as low as 50 deg. F. without risk of thermal shock.
- H. Required Pumping Configuration: It shall be acceptable to the boiler manufacturer for the boiler to be applied in a constant-primary (only) pumping system with external, field supplied pumps as shown on the Drawings. The primary pumps shall be controlled in an on/off fashion directly from the respective boiler controller to ensure that flow is provided when the boiler fires.
 - 1. For systems shown on the Drawings configured for primary-secondary pumping, the boiler may be furnished by the manufacturer with a factory-mounted primary circulating pump; however, the pump shall meet the characteristics and minimum performance of the pump scheduled on the Drawings. Boiler manufacturer-furnished pumps shall be as manufactured by Grundfos, Taco, Bell and Gossett, or Armstrong.
- I. Burner: Propane, forced draft, premix, stainless steel mesh type.
 - 1. Fully modulating control with minimum 5:1 turndown. The temperature control differential on the packaged boiler control shall be adjustable to recognize the specific level of burner turndown control provided by the burner.
 - 2. Burner shall produce no more than 20 ppm NO_x corrected to 3% excess oxygen.
- J. Blower: Centrifugal fan to operate during each burner firing sequence and to pre-purge and post-purge the combustion chamber.
 - 1. Motors: Variable speed. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - 2. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- K. Gas Train: ASME CSD-1 compliant; with manual shut-off, manual reset low and high pressure safety switches, dual motorized gas valves, pressure test ports, and manual leak checking gas valve.

1. The boiler shall be capable of operating with entering gas pressures as low as 04.0" w.c. and as high as 14.0" w.c.
- L. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
- M. Casing:
1. Jacket: Sheet metal, with snap-in or interlocking closures.
 2. Control Compartment Enclosures: NEMA 250, Type 1A.
 3. Finish: Protective paint or powder coat finish.
 4. Insulation: Minimum 2-inch thick, mineral-fiber or polyurethane-foam insulation surrounding the heat exchanger.
 5. Vent and Combustion-Air Connections: Inlet and vent duct collars.

2.3 TRIM AND ACCESSORIES

- A. Include devices sized to comply with ASME B31.9.
- B. Aquastat Controllers: Operating, firing rate, and high limit.
- C. Safety Relief Valve: ASME rated. Set for a relief pressure of 35 psi.
- D. Boiler Air Vent: Manual.
- E. Boiler Drain Valve: Minimum NPS 3/4 hose-end ball valve.
- F. Condensate Neutralizing Kit: Low profile design constructed of corrosion resistant materials. Tank shall incorporate baffles designed to channel flow thoroughly for complete neutralization, integral bypass to prevent condensate backflow into appliance. NPT connections with unions for connection to drain piping. Include initial charge of neutralizing agent. Size tank to suit the boiler size provided and its maximum projected condensing rate. Provide one dedicated tank per boiler.

2.4 CONTROLS

- A. Provide all pipeline controllers, relays, temperature sensors, outdoor temperature sensor (with sunshield), and control wiring to provide a complete and functional control system for the boiler plant. All sensors shall be hard wired (not wireless).
- B. Boiler Controls User Interface: LCD display with keypad, or touchscreen. Multiple status and configuration screens shall be available for easy interpretation of the hydronic loop status and simplified control configuration of the multiple hydronic boiler system. Screens available shall include:
1. Outdoor Reset Configuration
 2. Setback Schedule
 3. Lead/Lag Configuration
 4. Boiler Configuration
 5. System Status
 6. Alarm Status

7. Alarm History
8. System supply water setpoint mode adjustment capabilities shall be included and the setpoint mode shall be field adjustable at the user interface. Available setpoint modes shall include:
 - a. Internally programmed outdoor air reset schedule.
 - b. Manual.
9. Setback scheduling.
10. Collection of Trending Data.
11. Reporting of Alarm Status and History.
12. On-Off control of primary (boiler) pumps associated with each boiler / boiler module.

C. Boiler operating controls shall include the following devices and features:

1. Control transformer, factory wired from the unit single-point power connection.
2. Set-Point Adjustment: All set points and internal operating parameters shall be adjustable manually at the user interface.
3. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to provide the following stand-alone temperature control functions:
 - a. Supply Water Temperature Setpoint Control: Provide the following options:
 - 1) Reset supply-water temperature setpoint inversely with outside-air temperature. Reset parameters shall be fully adjustable.
 - 2) Fixed supply-water temperature setpoint, entered manually.
 - 3) Fixed supply water temperature setpoint, reset by way of a 0-10VDC or 4-20mA external control signal.
 - b. Each boiler shall energize an associated primary pump when the boiler burner is called to fire; and de-energize the pump when the burner is no longer firing, after an appropriate time delay. While firing, the boiler shall control the pump speed to maintain the required, pre-programmed rise in temperature across the boiler, as recommended by the boiler manufacturer.

D. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature.
2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.
3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
5. Flame Safeguard Control.
6. Differential Pressure Switch: To sense airflow to the burner.
7. The Master Controller may be a wall mounted, stand-alone unit. It is also acceptable for the individual boiler controllers to perform the specified integrating functions described herein.

8. The Master Controller shall be a microprocessor based process controller with a graphical user interface.

2.5 ELECTRICAL POWER

- A. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, control transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
 1. House electrical components in NEMA 250, Type 1 enclosure.
 2. Wiring shall be numbered and color coded to match wiring diagram.
 3. Install factory wiring outside of an enclosure in a raceway.
 4. Field power interface shall be to a non-fused lockable disconnect switch provided by the boiler manufacturer. If the manufacturer does not offer such a switch as factory equipment, a loose switch shall be furnished by the Division 23 Contractor to the Division 26 Contractor for field installation. Switch installation and additional wiring costs shall be borne by the Division 23 Contractor.
 5. Factory-provide branch power circuit to each motor and to controls with a circuit breaker. Provide each motor with overcurrent protection.

2.6 VENTING AND COMBUSTION AIR INTAKE

- A. Provide a complete combustion air and venting system that meets all requirements and recommendations of the boiler manufacturer. The boiler shall be vented as a CategoryIV appliance, with each boiler individually vented.
- B. Refer to Division 23 Section "Gas Vents" for venting materials and requirements.

2.7 SOURCE QUALITY CONTROL TESTING

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to the ASME Boiler and Pressure Vessel Code.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting performance of the Work.
 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

- A. Install boilers level and plumb, according to manufacturer's written instructions and referenced standards. Maintain required clearances.
- B. Equipment Mounting: Install boilers on the mechanical room wall. Provide supplementary galvanized steel channels and fasteners to anchor the units as required by the manufacturer.
- C. Install gas-fired boilers according to NFPA 54, ANSI Z223.1.
- D. Assemble and install boiler trim.
- E. Install electrical devices and sensors furnished with boiler but not specified to be factory mounted.
- F. Install control wiring to field-mounted electrical devices.
- G. Protect boiler fireside and waterside from corrosion.
 - 1. Before boiler is filled with water, protect by dry storage method recommended by boiler manufacturer.
 - 2. After boiler is filled with water, and left not fired for more than 10 days, protect by wet storage method recommended by boiler manufacturer.
 - 3. Chemical Treatment: Quality of water in boilers shall be maintained by a professional water-treatment organization that shall provide on-site supervision to maintain the required water quality during periods of boiler storage as well as during operating, standby, and test conditions. Refer to Division 23 Section HVAC Water Treatment for Closed-Loop Hydronic Systems" for additional requirements.
- H. Water Quality and Treatment Signage: Post in near proximity to each boilers and the closed loop system chemical feeding equipment permanent, framed signage indicating all system water quality and treatment requirements, including those reflecting the recommendations of the boiler manufacturer.
 - 1. The final language shall be coordinated between the Water Treatment Service Provider performing work of Division 23 Section HVAC "Water Treatment for Closed-Loop Hydronic Systems" and the boiler manufacturer's representatives, and shall be submitted to the Architect / Engineer as an informational submittal.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas-train connection. Provide a reducer if required. Natural gas piping is specified in Division 22.

- C. Install piping adjacent to boiler to allow service and maintenance.
- D. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve.
- E. Install piping from safety relief valves to nearest floor drain.
- F. Hydronic Connections: At the minimum, connect hot-water piping to supply- and return-boiler tapplings with shutoff valve, pressure gauge, temperature gauge, and union or flange at each connection. Inlet connections shall be provided with a strainer. Provide any additional appurtenances indicated on the Drawings.
- G. Boiler Venting and Combustion Air: Install flue venting system and combustion-air intake ductwork / piping. All aspects of the installation shall meet with the requirements and recommendations of the boiler manufacturer.
- H. Electrical: Comply with applicable requirements in Division 26 Sections.
- I. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- J. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- K. Controls Connections:
 - 1. Install control and electrical power wiring to field-mounted control devices.
 - 2. Connect control wiring between boilers and other equipment to interlock operation as required, to provide a complete and functioning system.

3.4 CLEANING

- A. Once all ASME code work is completed, Contractor shall do a boil-out of the boilers using any commercially available product for this purpose to remove mill oils, grease, foreign matter, etc. Compatibility of the proposed cleaning chemical shall be verified with the boiler manufacturer prior to use.
- B. The boil-out shall include "OVER-THE-TOP" wasting of water. A temporary 2" pipe shall be run from the relief valve tapping to a floor drain to assure that grease and oils are floated to the top and out of the unit. Minimum time for the procedure shall be three (3) hours of constant water discharge alternating between bottom and top blowdown. At least two (2) complete bottom blowdown and complete refills shall be done.
- C. After completing boiler installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes including chips, scratches, and abrasions.

3.5 FIELD QUALITY CONTROL

- A. Installation Supervisory Field Service: Engage a factory-authorized service representative to supervise the field assembly of components and installation of boilers, including piping and electrical connections. Report results in writing.
1. Perform installation checks according to manufacturer's written instructions.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment. Boiler shall be commissioned by factory-authorized technician. Contact local representative for factory authorized technician information.
 3. Verify that installation is as indicated and specified.
 4. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections. Do not proceed with boiler startup until wiring installation is acceptable to equipment Installer.
 5. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
- B. Start-Up Field Service: Manufacturer's representative shall supply a factory authorized service technician to start up the boilers.
1. Documentation shall be provided to the Client Agency following completion of startup and commissioning services. Operate boilers as recommended or required by manufacturer.
 2. Start-up shall be performed only after complete boiler room operation is field verified to offer a substantial load, and complete system circulation.
 3. Complete manufacturer's startup checklist and verify the following:
 - a. Boiler is level on concrete base.
 - b. Flue is installed without visible damage.
 - c. No damage is visible to boiler jacket or combustion chamber.
 - d. Pressure-reducing valves are checked for correct operation and specified relief pressure. Adjust as required.
 - e. Clearances have been provided and piping is flanged for easy removal and servicing.
 - f. Heating circuit pipes have been connected to correct ports.
 - g. Labels are clearly visible.
 - h. Boiler, burner, and flue are clean and free of construction debris.
 - i. Pressure and temperature gages are installed.
 - j. Control installations are completed.
 4. Ensure pumps operate properly.
 5. Check operation of gas pressure regulator device on gas train, including venting.
 6. Check that fluid-level, flow-switch, and high-temperature interlocks are in place.
 7. Start pumps and boilers, and adjust burners to maximum operating efficiency.
 8. Confirm proper fan motor rotation.
 9. Adjust air-fuel ratio.
 10. Fill out startup checklist and attach copy with Contractor Startup Report.
 11. Check and record performance of factory-provided boiler protection devices and firing sequences.
 12. Check and record performance of boiler fluid-level, flow-switch, and high-temperature interlocks.
 13. Make temperature limit adjustments to recognize the temperature limits of the venting material installed.

- C. Combustion Testing: Perform the following tests for maximum and minimum firing rates for modulating burner. Provide analysis equipment required to determine performance. Adjust boiler combustion efficiency at maximum and minimum modulation rates. Perform combustion flue gas test at minimum and maximum modulation rate. Report results. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are inadequate. Measure and record the following:
 - 1. Combustion-air temperature at inlet to burner.
 - 2. Flue-gas temperature at boiler discharge.
 - 3. Flue-gas carbon dioxide, oxygen, and carbon monoxide concentration.
 - 4. Flue gas NO_x emissions.
 - 5. Differential Pressure.
 - 6. Measure and record the water temperature rise through each boiler.
 - 7. Document test results in a report and submit to Architect.
- D. Repeat tests until results comply with requirements indicated.
- E. Boiler will be considered defective if it does not pass start up and combustion tests and inspections.
- F. Document test results in a report and submit to Architect.

3.6 OCCUPANCY ADJUSTMENTS

- A. When requested by the Client Agency within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two (2) visits to the project site during other than normal occupancy hours for this purpose. Visits to perform work covered by the manufacturer's or the Contractor's warranty shall not be counted against this allotment.

3.7 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Client Agency's maintenance personnel to adjust, operate, and maintain boilers. Also refer to Division 01 Section "Demonstration and Training."
 - 1. Operate boiler, including accessories and controls, to demonstrate compliance with requirements.
 - 2. Train Client Agency's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
 - 3. Review data in the maintenance manuals.
 - 4. Schedule training with Client Agency with at least 7 days' advance notice.

END OF SECTION

SECTION 237200

100% OUTDOOR AIR ENERGY RECOVERY VENTILATORS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Packaged air-to-air energy recovery ventilators for indoor applications.

1.3 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories. Include information for the following:
 - 1. Certified fan-performance curves with system operating conditions indicated.
 - 2. Certified fan-sound power ratings.
 - 3. Certified energy recovery heat exchanger performance ratings with system operating conditions indicated. Provide recommended frost control setpoints.
 - 4. Motor ratings and electrical characteristics plus motor and fan accessories.
 - 5. Material gages and finishes.
 - 6. Filters with performance characteristics.
 - 7. Dampers, including housings, linkages, and operators.
 - 8. Unit mounted temperature controllers and motor controllers.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, details, and attachments to other Work. For installed products indicated to comply with design loads, include structural analysis data.
 - 2. Design Calculations: Calculate requirements for selecting vibration isolators.
 - 3. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings, including floor plans and sections drawn to scale. Submit with Shop Drawings. Show duct and unit layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

- B. Field quality-control test reports. This shall include start up reports and functional test reports. Submit completed manufacturer's startup checklists.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data for units to include in the operation and maintenance manuals, including wiring diagrams, start-up and operating sequence and material list shall be provided to the Client Agency. The Client Agency shall be provided with complete instruction of operating and maintenance procedures.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Energy recovery heat exchangers shall be tested and rated in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment. Products that are not AHRI certified shall not be acceptable.
- C. UL Compliance: Packaged heat recovery ventilators shall comply with requirements in UL 1812, "Ducted Heat Recovery Ventilators".
- D. Fans, except for fans with motors smaller than 5 HP, shall have a fan efficiency grade (FEG) of no less than 67, when tested in accordance with AMCA 205 "Energy Efficiency Classification for Fans", and shall have a design point efficiency within 15 percentage points of the maximum total efficiency, in compliance with the 2015 International Energy Conservation Code.

1.7 COORDINATION

- A. Coordinate layout and installation of air-handling units with ductwork and with other installations.
- B. Coordinate motor starting and control requirements with Division 26 and the ATC system supplier / sub-contractor.
- C. Coordinate the supply voltage and phase of motors and other electrical connections with Division 26.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of air-to-air energy recovery equipment that fail in materials or workmanship within specified warranty period.

- 1. Warranty Period for Energy Recovery Heat Exchanger: Non-prorated for five (5) years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
1. Units Incorporating Enthalpic, Fixed-Plate / Membrane Heat Exchangers:
 - a. Micrometl
 - b. Innovent
 - c. Munters
 - d. XeteX Inc.

NOTE: All energy recovery ventilators other than those indicated to be the '*Basis of Design*' shall be considered 'alternate energy recovery ventilators ' for purposes of this specification, including the paragraph below.

- B. It is the full burden of the Contractor to include in his bid the costs associated with making all required modifications to the design and installation, at no additional cost beyond that accounted for in the bid price, in order to accommodate the specific installation requirements of the alternate energy recovery ventilator, including those affecting the work of other Divisions. The design modifications shall meet with the approval of the Architect and Engineer. The Architect and Engineer are the sole determiners of acceptability.

2.2 PACKAGED ENERGY RECOVERY UNITS

- A. General: Provide packaged energy recovery units to include energy recovery heat exchanger, supply air and exhaust air blowers, motors with and relays, outside and exhaust air filters, and adjustable defrost control.
- B. Base Construction: Unit shall have a welded structural steel base with structural supports under blowers and components. Frame shall be coated with rust inhibiting paint. Lifting lugs shall be an integral part of the base. Unit floor shall be minimum 16 gauge galvanized steel.
- C. Cabinet Construction: Unit cabinet shall be of formed heavy gauge galvanized steel supports (18 gauge minimum). Outer panel skin shall be minimum 22 gauge galvanized steel sheet. Unit shall be completely insulated with minimum 1" thick, closed-cell or expanded R-6 foam insulation.
1. Provide access to all exchanger surfaces, blowers, motors, filters, through double wall gasketed access doors held closed by adjustable cam-lock latches. Continuous hollow rubber gasket shall be applied to all access openings to provide water and air-tight seals.
 2. Provide a motorized outside air shut-off damper and exhaust air motorized damper.
- D. Enthalpic Fixed Plate / Membrane Heat Exchanger: The enthalpy exchanger shall provide high performance sensible and latent transfer between the airstreams. This transfer shall be accomplished by moving energy (both sensible and latent) molecularly through the enthalpy exchanger surface by way of hygroscopic resins while keeping the airstreams physically separated. "Porous plate" mechanisms are not acceptable. The air to air enthalpy exchanger shall

be of the fixed plate type and have no moving parts, surface adhered desiccants, or paper parts. The unit shall be capable of both summer and winter operation with no condensation buildup or condensate management without preheat or outdoor air bypass, as long as the indoor relative humidity is below 40% and outdoor air temperatures are above -10 deg. F. Frosting shall result in no permanent damage to the heat exchanger core.

- E. Fans: Fans shall be forward curved DWDI for quiet efficient operation arranged in a draw through configuration relative to exchanger. Motors shall be efficient TEFC or ODP T-frame, 1750 rpm nominal with minimum service factor of 1.15 mounted on adjustable base. Motor and blower shall be mounted on common frame and isolated from unit case with rubber-in-shear type vibration isolators and flexible duct connections. Motors and blowers shall have V-belt drives with variable pitch sheaves on motors.
- F. Electrical: Factory wired for a single point electrical connection at the voltage and phase indicated on the Drawings. Electrical controls shall include magnetic motor starters with overloads, fuses, control transformer for low voltage controls, service switch and terminal points. A main non-fused disconnect switch in a NEMA 1 enclosure shall be provided.
- G. Filters: Outdoor air and return/exhaust air filters shall be 2" thick pleated, 30 percent efficient, MERV 8, throwaway type. Filters shall be mounted within unit in galvanized holding frames upstream of exchanger and accessible through access panels.
 - 1. Provide factory installed filter monitors (differential pressure switches) for each airstream.
- H. Dampers: Provided on each airstream to isolate the building from the exterior, formed from 16 gauge galvanized hat channel frames and blades with 1/2" cadmium plated shafts and bronze bearings. Low leakage dampers have vinyl blade seals and stainless steel jamb seals. Outside air damper be parallel blade type with 2-position overload proof direct coupled actuator. Exhaust air damper may be an adjustable counterweighted backdraft damper to be parallel blade with extruded aluminum blades and frame, low leakage type with silicone seals, in lieu of motorized
- I. Controls: Controls shall be factory installed in the unit. Provide the following:
 - 1. Starting relay, factory mounted and wired, and magnetic motor starter for field wiring, for each fan.
 - 2. Motorized isolation dampers on OA intake and exhaust airstream shall be interlocked with the respective fan.
 - 3. Frost Prevention: Achieved by outside air bypass Frost setpoint temperatures shall be based on the scheduled design air conditions shall be provided by the unit manufacturer.
 - a. Winter design supply and exhaust air conditions leaving the energy recovery device shall be provided by the unit manufacturer and shall include any de-rating in performance due to frost prevention measures.

2.3 MOTORS

- A. Refer to Division 23 Section "Common Motor Requirements for HVAC Equipment" for general requirements for factory-installed motors.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine installation location for compliance with requirements for conditions affecting installation and performance of units. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Examine casing insulation materials and filter media before air-to-air energy recovery equipment installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for electrical services to verify actual locations of connections before installation.

3.2 INSTALLATION

- A. Install energy recovery units level and plumb, and in accordance with manufacturer's recommendations.
- B. Connect ducts so supply and exhaust airstreams flow in opposite directions
- C. Install units with clearances for service and maintenance.
- D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters at the time of turnover. Provide an additional set(s) of filters as described herein under "Extra Materials".
- E. Provide an allowance for one sheave and one belt change for each air handling unit during balancing procedures.

3.3 CONNECTIONS

- A. Drawings indicate general arrangement of ducts, fittings, and specialties. Make final duct connections with flexible connections.
- B. Comply with requirements for ductwork specified in Division 23 Section "Ductwork."

3.4 CLEANING

- A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.
- B. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.

- C. Prior to startup, provide final cleaning of air handling units to remove road debris from interior and exterior of unit. The interior airstream surfaces of the unit shall be oil and grease free and wiped clean with 50-50 mix of denatured alcohol and water.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect equipment installation, including ductwork and electrical connections. Report results in writing.
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Specific procedures shall include:
 - a. Verify that installation is as indicated and specified.
 - b. Complete manufacturer's installation and startup checks and perform the following:
 - 1) Inspect for visible damage to unit casing.
 - 2) Verify that clearances have been provided for servicing.
 - 3) Check that labels are clearly visible.
 - 4) Verify that controls are connected and operable.
 - 5) Remove shipping bolts, blocks, and tie-down straps.
 - 6) Verify that filters are installed.
 - c. Adjust vibration isolators.
 - d. Check operation of dampers.
 - e. Lubricate bearings on fan.
 - f. Check fan-wheel rotation for correct direction without vibration and binding.
 - g. Adjust fan belts to proper alignment and tension.
 - h. Start unit according to manufacturer's written instructions.
 - i. Check and record performance of interlocks and protection devices; verify sequences.
 - j. Operate unit for an initial period as recommended or required by manufacturer.
 - k. Check internal isolators.
 - l. Check damper for proper stroke and interlocks.
- B. Remove malfunctioning units, replace with new units, and retest as specified above.

3.6 FUNCTIONAL TESTING

- A. Scope and Involved Parties: After installation, cleaning, start-up, and testing, adjusting, and balancing procedures have been satisfactorily completed, each unit installed shall be functionally tested.
 - 1. All problems encountered during equipment installation, start-up, and air balancing and water balancing shall be completed and debugged before functional testing may begin.

2. The functional performance tests conducted shall demonstrate that each unit and system is operating according to the documented design intent, sequence of operations, and Contract Documents.
 3. The (installing) Division 23 Contractor, representative from the equipment supplier, and the DDC System Sub-Contractor shall cooperate in the integration of the unit operation and the building control system during field installation and functional testing.
- B. Functional Testing Procedures: The completed unit shall be tested for correct functionality in all operating modes by the above parties. The functional testing shall consist of an in-unit test of the controller, inputs, outputs, safeties, and all aspects of the sequences of operation. All operating modes (occupied, unoccupied, etc.) shall be tested, as are start-up, shut-down, restart after power failure. Proper response to failure and alarm conditions (e.g. freeze condition, low oil pressure, no flow, equipment failure, etc.) shall also be tested. Also, part of the functional test will be verification of the operation of compressor(s), fan(s), damper and valve actuators, and associated electrical components.
1. The Division 23 (installing) Contractor shall:
 - a. Review the proposed tests for feasibility, safety, and equipment and warranty protection. Advise the DDC System Sub-Contractor of required modifications.
 - b. Provide technicians, instrumentation, and tools to facilitate the tests.
 - c. Operate the equipment and systems they have previously installed during the tests.
 - d. Assist in tests of equipment and systems with which their work interfaces.
 2. The equipment manufacturer or supplier representative shall:
 - a. Provide a minimum of 4 hours of on-site factory technician time (time exclusive of travel to the site) per unit supplied to assist in functional testing, problem solving, and controls integration.
- C. Functional Testing Report: Report findings during functional testing. Identify testing procedures, problems encountered, corrective measures taken, and final results.

3.7 DEMONSTRATION AND TRAINING

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

END OF SECTION

SECTION 238216

AIR COILS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hot water coils.

1.3 ACTION SUBMITTALS

- A. Product data including rated capacities of selected models, pressure drop, weights (shipping, installed, and operating), installation instructions, and startup instructions.
- B. Shop drawings detailing fabrication and installation of air coils, including plans, elevations, sections, details of components, and attachments to other units of Work. Detail connections to piping. Indicate dimensions, weight loadings, weight distribution, and clearances required. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating coil location and ceiling-mounted access panels.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data for air coils to include in the operation and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Comply with ARI 410, "Standard for Forced-Circulation Air-Cooling and Air-Heating Coils," and ASHRAE 33 for components, construction, and rating.

1.7 COORDINATION

- A. Coordinate layout and installation of air coils with duct, insulation, and with other installations. Revise locations and elevations from those indicated as required to suit field conditions, and as approved by the Architect.

PART 2 - PRODUCTS

2.1 HOT-WATER COILS

- A. Description: Continuous circuit coil fabricated to ARI 410.
- B. Piping Connections: Threaded, on same side.
- C. Tubes: Min. 0.025" thick copper tube, 1/2" or 5/8" diameter, with aluminum fins spaced no closer than 0.1 inch, in galvanized steel channel frame designed for a flanged connection.
 - 1. Fin and Tube Joint: Mechanical bond.
 - 2. Min fin thickness: .008".
 - 3. Casings: Galvanized steel.
- D. Minimum Working-Pressure/Temperature Ratings: 200 psig at 325 deg F.
- E. Source Quality Control: Leak test to 400 psig under water.
- F. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1. Aerofin Corporation.
 - 2. Capitol Coil and Air
 - 3. Carrier Corporation.
 - 4. Daikin
 - 5. Diversified Heat Transfer Inc.
 - 6. Greenheck
 - 7. Johnson Controls
 - 8. Marlo, division of DRS Technologies.
 - 9. Trane
 - 10. USA Coil & Air.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine ducts to receive air coils for compliance with requirements for installation tolerances and other conditions affecting performance of the air coils. Verify piping rough-in dimensions. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install air coils level and plumb, and according to manufacturer's written instructions, rough-in drawings, the original design, and referenced standards.
- B. Install air coils in metal ducts constructed according to SMACNA "HVAC Duct Construction Standards."
- C. Provide a duct access door upstream of all duct coils.
- D. Anchor air coils in position using suitable supports. Support coils independently of connecting ductwork.
- E. Install piping connections, maintaining manufacturer's recommended clearances for service and maintenance of coils.
- F. Install shutoff valves at coil inlet and outlet connections.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. The Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
 - 1. Install piping adjacent to machine to allow service and maintenance.
 - 2. Connect piping with flexible connectors. Support piping independently of unit and coils.
 - 3. Hot Water Piping: Conform to applicable requirements of Division 23 Section "Hydronic Piping." Connect to supply and return coil tapings with shutoff or balancing valve and union or flange at each connection, if appurtenances are not indicated on the Drawings.

3.4 ADJUSTING

- A. Comb bent fins on each air coil.

3.5 CLEANING

- A. After completing system installation, including duct and fittings, clean coils using materials and methods recommended by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

END OF SECTION

SECTION 238239

HYDRONIC UNIT HEATERS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.
- B. Division 23 Section 230513 "Common Motor Requirements for HVAC Equipment".

1.2 SUMMARY

- A. This Section includes propeller unit heaters for hydronic heating applications.

1.3 ACTION SUBMITTALS

- A. Product data for each type of product specified, including capacities, operating characteristics, furnished specialties, and accessories.
- B. Samples of cabinet finish colors for approval. Samples shall be paint chips (i.e. not a color PDF file).

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data for heating units to include in the operation and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Comply with NFPA 70 for components and installation.
- B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
1. Daikin
 2. Reznor, a Division of Nortek Co.
 3. Rittling, a Zehnder Group Company
 4. Sigma Corporation
 5. Sterling Radiator, a Div. of Mestek, Inc. (Basis of Design)
 6. Trane
 7. Vulcan, a Div. of Mestek, Inc.

2.2 PROPELLER HYDRONIC UNIT HEATERS

- A. Casing: Minimum 18-gauge sheet steel with hanging brackets and removable access panels to remove, service, and maintain major components. Provide cabinet with factory baked enamel finish of color selected by the Architect.
- B. Coil: Fin-and-tube coil fabricated of copper with aluminum fins spaced no closer than 0.1 inch, and galvanized steel casing. Provide coil with vent and drain fittings. Test for leaks to 450 psig under water. Coil shall be suitable for no less than 200 psig working pressure and a maximum entering water temperature of 220 deg. F.
- C. Fan and Motor: Direct-drive propeller fan and manufacturer's standard permanent split-capacitor or ECM type motor, as scheduled, with thermal overload protection and disconnect switch.
- D. Stand Alone Unit Controls: Conduit mounted, 120-volt thermostat and strap-on aquastat wired in series. Thermostat shall energize the unit fan and fully open the hot water valve upon a drop in space temperature, when hot water is available, as sensed by the aquastat. On a rise in space temperature, the fan shall be de-energized and the hot water valve shall be fully closed (via spring return).
- E. Unit Configuration: Horizontal or vertical discharge, as indicated, with adjustable louvers.
- F. Accessories: Include the following:
1. Disconnect switch.
 2. Hanger rods with vibration isolators.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and supports to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of units. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.

3.2 INSTALLATION

- A. Install unit heaters as indicated, according to manufacturer's written instructions and NFPA 90A.
- B. Install recessed wall units in finished wall assembly; seal joints. Joint-sealant materials and applications are specified in Division 07.
- C. Connect heating units and components to piping according to Division 23 Section "Hydronic Piping."
- D. Connect unit heaters and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.

3.3 FIELD QUALITY CONTROL

- A. Testing: After installing unit heaters and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
- B. Remove and replace malfunctioning units with new units and retest.

3.4 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Clean units to remove dirt and construction debris and repair damaged finishes.
 - 1. Touch-up Painting: Apply touchup paint to match factory finish on minor scratches in the cabinet finish. Large visible scratches will require cabinet replacement, at the direction of the Architect / Engineer.

3.5 DEMONSTRATION

- A. Train Client Agency's maintenance personnel to adjust, operate, and maintain unit heaters.

END OF SECTION

SECTION 238249

ELECTRIC UNIT HEATERS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.
- B. Division 23 Section 230513 "Common Motor Requirements for HVAC Equipment".

1.2 SUMMARY

- A. This Section includes space heating units for electric resistance type applications.

1.3 ACTION SUBMITTALS

- A. Product data for each type of product specified.
- B. Wiring diagrams detailing power and control wiring and differentiating clearly between manufacturer-installed wiring and field-installed wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Samples of cabinet finish colors for approval.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data for units to include in the operation and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Comply with NFPA 70 for components and installation.
- B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
1. Electric Wall Heaters:
 - a. Brasch Manufacturing Co., Inc.
 - b. Dimplex North America
 - c. Markel Products Company; a Div. of TPI Corp.
 - d. Berko; a Div. of Marley Electric Heating Co.
 - e. Qmark; a Div. of Marley Electric Heating Co. (Basis of Design)
 - f. Reznor, a Nortek Company
 - g. Trane, a Division of Ingersoll Rand

2.2 ELECTRIC WALL HEATERS

- A. General: Provide electric wall heaters of the forced air circulation, recessed type. Box and internal sheet metal parts shall be not less than No. 20-gauge steel. Enclosures shall be provided with baked-on enamel, corrosion-resistant finish. Grilles shall be 16-gauge steel, louvered type. Louvers shall be positioned for downflow air discharge.
1. Heaters shall be designed for a recessed wall installation.
 2. Provide a surface mount trim kit for those heaters indicated on the Drawings to be surface mounted.
- B. Components: Heater assembly shall consist of completely enclosed heating elements, fan, thermostat and automatic thermal cutout safety devices.
1. The heating elements shall consist of nickel-chrome-iron alloy wire heater imbedded in a refractory material enclosed in a finned metal sheath.
 2. Fan shall be propeller type, directly mounted on motor shaft. Motor shall be thermally protected, lifetime lubricated, suitable for continuous operation. Motor shall be wound to required voltage or provided with a transformer. Provide a NEMA KS 1, Type HD disconnect switch, with lockable handle.
 3. Heaters shall be provided with built-in, adjustable thermostat.
 4. Line voltage control contactors and 24V control transformer.
 5. Fan delay relay to dissipate residual internal heat after elements have been de-energized.
 6. The thermal cutout devices shall disconnect the heating elements from the power supply should the temperature of the heating elements exceed normal conditions and shall be of the automatic reset type.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and supports to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of units. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install unit heaters as indicated, according to manufacturer's written instructions and NFPA 90A.
- B. Install recessed wall units in finished wall assembly; seal joints. Joint-sealant materials and applications are specified in Division 07.
- C. Connect unit heaters and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.

3.3 FIELD QUALITY CONTROL

- A. Testing: After installing unit heaters and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
- B. Remove and replace malfunctioning units with new units and retest.

3.4 CLEANING

- A. Replace filters in each cabinet unit heater at Substantial Completion.
- B. After completing system installation, including outlet fittings and devices, inspect exposed finish. Clean units to remove dirt and construction debris and repair damaged finishes.
 - 1. Touch-up Painting: Apply touchup paint to match factory finish on minor scratches in the cabinet finish. Large visible scratches will require cabinet replacement, at the direction of the Architect / Engineer.

3.5 DEMONSTRATION

- A. Train Client Agency's maintenance personnel to adjust, operate, and maintain unit heaters.
 - 1. Train Client Agency's maintenance personnel on procedures and schedules for troubleshooting, servicing, and maintaining equipment.
 - 2. Review data in maintenance manuals.

3. Schedule training with Client Agency, through Architect, with at least seven days' advance notice.

END OF SECTION

SECTION 238316

RADIANT FLOOR HYDRONIC TUBING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Work of this Section includes a complete underfloor radiant heating system including radiant heating tubing, including fittings control system, and tubing specialties, delegated design, and manufacturer-supported system installation site observations and start-up/ commissioning support services.
- B. Related Sections include the following:
 - 1. Division 23 Section -Common Work Results for HVAC- for general piping materials and installation requirements.
 - 2. Division 23 Section -Meters and Gages for HVAC Piping- for thermometers, pressure gauges, and PT test ports.
 - 3. Division 23 Section -Hangers and Supports for HVAC Piping and Equipment- for pipe supports, product descriptions, and installation requirements.
 - 4. Division 23 Section -Identification for HVAC- for labeling and identifying piping and equipment.
 - 5. Division 23 Section -Hydronic Piping- for balancing valves and piping connections to hydronic systems.

1.3 DEFINITIONS

- A. DIN: German Institute for Standardization
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.
- C. PEX: Crosslinked polyethylene.

1.4 PERFORMANCE REQUIREMENTS AND DELEGATED DESIGN

- A. Provide the radiant floor heating system in the areas indicated on the Drawings. Locate manifold(s) and slab tubing entrance(s) where indicated on the Drawings.

- B. The tubing manufacturer shall provide design services to determine the number of circuits, individual circuit lengths, water temperature, tubing spacing, pressure drop, and water temperature drop within the requirements of the performance schedule indicated on the Drawings. The design shall comply with the following:
1. Layout tubing and circuiting so as to equalize lengths to the greatest extent possible. The shortest circuit length shall be no less than 80% of the average circuit length, and the longest circuit length shall be no greater than 120% of the average circuit length.
 2. Calculations supporting the layout shall be performed using the tubing manufacturer's current standard computer software.
 3. Submit the proposed design for approval. Refer to the requirements for calculations and shop drawings in the Article titled -Action Submittals- herein.

1.5 ACTION SUBMITTALS

- A. Product Data: Radiant heating tubing and tubing specialties, and control devices, including rated capacities and water flow and pressure drops of selected models.
- B. Shop Drawings and Performance Calculations: Prepare drawings and calculations in accordance with the layout shown on the Drawings, performance requirements specified in this Section and details and notes indicated on the Drawings. Show tubing layout and details drawn to scale, including valves, manifolds, controls, and support assemblies and their attachments to the building structure. Provide wiring diagrams for control system components.
1. Layout scale: 1/4 inch = 1 foot.
 2. Submit manufacturer's detailed drawings showing layouts, fixing details and tubing details of all areas where hydronic radiant systems are indicated. Provide details for the relationship of supplied materials with the work of all other trades.
 - a. Coordinate floor or slab tubing layout with other devices (electrical conduits and boxes, telecommunication conduits and boxes, plumbing penetrations, construction and furniture supports) and all other services within or attaching to the slab or floor.
 - b. Coordinate the slab tubing layout with construction, expansion, and control joints.
 3. Submit a cross-referenced manifold schedule indicating loop lengths, tubing diameter, flow rate, operating water temperatures, and pressure drop to meet the required heating performance indicated on the Drawings along with product and performance data for each component.
 4. Provide calculations that support the heating performance requirements of the hydronic radiant system. These calculations shall indicate the floor or slab construction and the depth of the tubing in relation to the exposed surface. Calculations shall indicate the required flow rate, operating temperatures and pressure drops through the system.
 5. Submit manifold details, including all connections, fittings, valves and mounting requirements.
 6. Submit details for embedded tubing through concrete expansion joints.
 7. Provide drawings showing tubing manifold locations and installation details.
 8. Provide control sequences and requirements for control hardware devices. Indicate compliance and coordination with requirements of other specification sections.

9. Indicate all valves, pumps and items of equipment that are required to automatically control and operate the hydronic radiant system as shown on the Drawings and described in the sequence of operations. Submit a valve and pump schedule listing each number, type, size, model and service. Cross reference to supporting product data.
- C. Installation Instructions: Provide manufacturer's instructions. Note any exceptions proposed for the installation of the system on this project.

1.6 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Qualifications: Documentation demonstrating that the installer is trained to install the manufacturer's products and has successfully completed a hydronic radiant system installation training course offered by the PEX tubing manufacturer. Such documentation shall be provided for each worker proposed to be involved in the system installation.
- B. Installer Experience: Documentation demonstrating that each of the proposed workers have prior experience on at least two (2) projects of similar size and complexity.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For valves, manifolds, and control devices to include in maintenance manuals.
- B. Manufacturer's report detailing that the hydronic radiant system has been installed in accordance with the contract documents and the manufacturer's specified instructions.
- C. Start-up report demonstrating that system meets required capacity, is fully functional and commissioned to the satisfaction of system manufacturer.
- D. Dimensioned 'as-built' drawings indicating tubing layout, loop lengths, manifold locations, zoning and manifold schedules with details required for installation of the system.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Installer shall have demonstrated experience on at least two (2) projects of similar size and complexity. Installer shall have successfully completed a hydronic radiant system installation training course offered by the PEX tubing manufacturer.
- B. Manufacturer Qualifications: Hydronic radiant system manufacturer and manufacturer's on-site representative shall have successfully completed non less than ten (10) installations of similar type and scope. Manufacturer shall provide a representative for field support during the installation and commissioning of the hydronic radiant system.
- C. Single Source Requirements: To the greatest extent possible, provide hydronic radiant flooring systems and ancillary products specified in this section from a single manufacturer.
- D. Pre-Installation Meeting: Prior to the installation of the radiant heating system, the Division 23 Contractor and the Contractor performing the general construction shall meet on-site with the radiant heating system manufacturer's field representative to review the following:

1. Verify project requirements, substrate conditions, floor coverings, manufacturer's installation instructions and warranty requirements.
 2. Interface with other trade representatives to verify areas of responsibility.
 3. Establish the frequency and construction phase the project engineer intends for site visits and inspections by the manufacturer's representative.
- E. Manufacturer's Field Services: No less than three (3) site visits are required by the radiant heating system manufacturer's representative. These visits shall occur at the following stages of construction:
- a. At the pre-installation meeting.
 - b. After system installation but prior to slab pour / concealment.
 - c. Upon system start up and commissioning.

1.9 STORAGE AND HANDLING

- A. Protect tubing from sunlight / UV exposure, and from oil, grease, paint, and adhesives.
- B. Protect tubing and manifolds from entry of contaminating materials. Install suitable plugs in open tubing ends until installation.
- C. Where possible, connect tubing to assembled manifolds to eliminate possibility of contaminants and cross-connections.
- D. Tubing shall not be dragged across the ground or other surfaces, and shall be stored on a flat surface with no sharp edges.

1.10 COORDINATION

- A. Coordinate layout and installation of radiant heating tubing with building and structural components, including slab expansion joints, insulation, and saw-cut control joints.
- B. Coordinate size and location of access panels to allow access to manifolds concealed in ceilings, walls, and floors.
- C. Coordinate thickening of slabs where required for adequate encasement of radiant heating tubing components.
- D. Revise locations and elevations from those indicated as required to suit field conditions and ensure integrity of tubing and as approved by Architect.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:

1. Uponor
2. Zurn Plumbing Products Group
3. Rehau
4. Viega LLC
5. Mr. Pex Systems

2.2 HEAT-TRANSFER TUBING AND FITTINGS

- A. PEX Plastic Tubing: ASTM F 876 for service at 100 psig and 180 deg F., with an oxygen diffusion barrier limiting oxygen diffusion to a rate of 0.10 g/m³/day at 104 deg F. water temperature in accordance with (German) DIN Standard 4726.
 1. Nominal Inside Diameter: Provide tubing with nominal inside diameter in accordance with ASTM F876, as indicated on the Drawings.
- B. Fittings: ASTM F 1807 brass or copper crimp ring type, or ASTM F 2080, copper or brass compression-sleeve type.
 1. The fittings shall be approved for use by the PEX tubing manufacturer.

2.3 SPECIALTIES

- A. Base Mats: Minimum 2- thick and 1.5 lb./ cu ft. density expanded polystyrene (EPS) foam insulation sheet with integral vapor barrier and with formed pipe channels, knobs, or clips at 2-intervals on the top surface designed to hold PEX tubing in place during concrete slab pour.
 1. Panel shall have a minimum insulating value of R-10 per ASTM D 1622 at 75 deg. F.
 2. Vapor barrier per rating shall be no greater than 2.0 perms per ASTM E 96.
 3. Compressive strength of the panel shall be no less than 45 psi per ASTM D 1621.
 4. Product shall be S45- from Creatherm, or approved equal.
- B. Expansion Stripping: Flexible joint to protect wall from concrete and allow expansion.
- C. Distribution Manifolds: Factory fabricated. Brass, copper or stainless steel, modular design with pump, mixing valve, main shutoff valves, PT ports, air vents, drain valves, and zone shutoff and calibrated balancing valves and identification plates as detailed on the Drawings. Pressure rating of no less than 100 psig at 180 deg F.
 1. The entire assembly shall be mounted in a minimum 20-gauge furniture quality steel cabinet designed for surface mounting on a wall. The cabinet shall have a baked enamel paint or powder coat finish in off-white. The access door shall have a concealed piano hinge, and key lock.
 2. Identification Plates: Valve plate shall identify room(s) served, loop number, and the verified / actual installed loop length.
 3. If more than one loop serves a room, provide identification plates on manifolds to identify rooms served.

4. Valves and other appurtenances detailed on the Drawings shall comply with the applicable requirements in other Division 23 Sections, including -Meters and Gages for HVAC Piping-, -Hydronic Piping-, -General Duty Valves for HVAC Piping-, and -Instrumentation and Control for HVAC-.

2.4 CONTROLS

A. Space (Room) Thermostats:

1. Minimum temperature range from 50 to 90 deg F.
2. Manually operated with on-off switch.
3. Day and night setback and clock program with minimum four periods per day.
4. Operate pumps or open zone control valves if room temperature falls below the thermostat setting, and stop pumps or close zone control valves when room temperature rises above the thermostat setting.

B. Slab Temperature Sensors: Hermetically sealed, moisture proof 10K ohm NTC thermistor type, with a thermally conductive coating. Wire length shall be as required to place the sensor at any location in the heated slab, or where indicated on the Drawings.

1. Range: 4 to 176 deg. F.
2. Accuracy: +/- 0.5 deg. F.

C. Space Temperature Controller: Modular controller allows control of loop control valves by space thermostats, with connections for pump relay; with 24-V, 40-A transformer.

D. Indoor Space Radiant Heating Control System: Provide a complete control system for the radiant floor heating system tubing, including adjustable controllers, space thermostat, piping and slab temperature sensors, wiring, conduit, relays, and other accessories. The water temperature through radiant heating tubing shall be modulated to satisfy the space thermostat, while preventing supply water temperature to tubing, or the slab temperature itself, from exceeding their respective high limit values.

E. Mixing Valves: 125 psig, 230 deg. F maximum operating pressure and temperature, brass or cast-bronze body, EPDM seals, and threaded connections, 3 or 4 way as noted.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive radiant-heating tubing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Ensure that surfaces in contact with radiant-heating tubing are free of burrs and sharp protrusions.
2. Ensure that surfaces and substrates are level and plumb.

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

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install radiant heating system according to approved shop drawings or coordination drawings.
- B. Comply with manufacturer's installation instructions and design drawings, including product technical bulletins.
- C. Install no less than 2" thick rigid extruded polystyrene board insulation with a minimum R value of 3.5 per inch of thickness underneath the entire slab containing the radiant tubing heating system.
- D. Install edge insulation when the heated concrete slab system directly abuts an unheated slab or exterior building wall. Insulation shall be minimum 2" thick, or the thickness identified on the Architectural Drawings, whichever is larger.
- E. Provide slab expansion joints where heated concrete slabs abut interior walls or unheated slabs.
- F. Install slab temperature sensors in locations recommended by the tubing or control system manufacturer, or where explicitly shown on the Drawings.
- G. Install and wire all components of the control system.

3.3 HEAT-TRANSFER TUBING INSTALLATION

- A. Install tubing downstream from manifolds without joints.
- B. Keep above-floor tubing ends capped until connected to the hydronic system to prevent entry of debris.
- C. Bend tubing at a radius no less than recommended by the tubing manufacturer.
- D. Secure tubing in concrete slab on grade floors by attaching tubing to insulated panel.
 - 1. Install tubing at a consistent depth below the surface elevation. Maintain 2-inch minimum cover, or the amount detailed on the Drawings, whichever is larger. Also ensure sufficient clearance to avoid control joint cuts.
 - 2. In areas where tubing must cross expansion joints, ensure the tubing passes below the joints. If this is not possible, install a sleeve of foam-type insulation around tubing and extending for a minimum of 6 inches on each side of the slab penetration to protect the tubing passing through expansion joints, with the insulation thickness no less than the maximum predicted sheer movement between slabs, or 1/2", whichever is greater.
 - 3. Prior to slab pour, carefully inspect all tubing and check all steel reinforcing mesh and tie wires to verify that no sharp wire ends that could puncture the tubing are protruding near the tubing.
 - 4. Protect the tubing where it sweeps upward to exit the slab with a 90-degree long radius schedule 80 PVC pressure tubing elbow.
 - 5. Maintain minimum 40-psi pressure in tubing during concrete placement and continue for 24 hours after placement.

- E. Install manifolds in accessible locations, as shown on the Drawings. Install the supply-and-return tubing to the manifold in a reverse-return configuration to ensure self-balancing.
- F. Install embedded slab sensors away from system tubing, half way between adjacent tubes, at an elevation in the slab 1- above the top of the tubing. Sensor shall be installed in 1/2- diameter copper tube with an end cap with the open end routed to an accessible location to permit future replacement of the sensor.
- G. Comply with requirements in Division 23 Section -Hydronic Piping- for connections to hydronic systems and for flushing and filling requirements.
- H. Fill system with 40 percent of propylene glycol-to-water solution.
- I. If the radiant heating system substrate material (thermal mass) requires curing and/or has other limitations which can be influenced by the radiant heating system while in operation, then the radiant heating system shall not be put into operation until such time that the substrate material has fully cured or set according to the material requirements of the substrate manufacturer.

3.4 FIELD QUALITY CONTROL

- A. Prior to concealment or concrete slab pour, perform the following:
 - 1. Test tubing system as specified below.
 - 2. Provide survey documentation of tubing layout after installation of tubing and prior to pouring concrete. This information shall be incorporated into the 'as-built' documents.
 - 3. Engage the manufacturer's field representative to examine the completed system installation for compliance with the manufacturer's requirements and recommendations. The field representative shall issue a report detailing that the hydronic radiant system has been installed in accordance with the contract documents and the manufacturer's specified instructions and is approved for concealment or slab pour.
 - 4. Notify the Client Agency and the Architect/Engineer no less than five (5) days in advance of concealment or concrete slab pour to allow inspection of installation and survey documentation.
 - 5. If any of the above are not fully completed, the slab pour or concealment shall not occur.
- B. Prepare radiant heating tubing for testing as follows:
 - 1. Flush with clean water, and clean strainers.
 - 2. Install relief valve set at a pressure no more than one-third higher than test pressure.
- C. Perform the following tests:
 - 1. Subject tubing to hydrostatic test pressure that is not less than 1.5 times the design pressure but not more than 80 psig
 - 2. After hydrostatic test pressure has been applied, examine tubing, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 - 3. Prepare a written report of testing.

3.5 ADJUSTING

- A. Adjust temperature control setpoints and safety limit values. Verify proper operation of valves and equipment to meet the required sequence of operation.
- B. Balance all loops across each manifold to the flow rates specified on the approved manifold schedule. Comply with Division 23 Section -Testing, Adjusting, and Balancing for HVAC-.
- C. After system balancing has been done, mark balancing (zone) valves to permanently indicate final position.
- D. Perform the following adjustments before operating the system:
 - 1. Open valves to fully open position. Close bypass valves.
 - 2. Check operation of automatic valves.
 - 3. Set temperature controls so all zones call for full flow.
 - 4. Purge air from piping.

3.6 CLEANING

- A. After testing has been successfully completed, flush tubing and clean strainer screens.

END OF SECTION

SECTION 260500

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.
- B. Additional Related Sections Include:
 - 1. Division 26 Section "Commissioning of Electrical" for commissioning of systems and equipment.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. General administrative and procedural requirements.
 - 2. Electrical demolition.
 - 3. Cutting and patching for electrical construction.

1.3 GENERAL STIPULATIONS

- A. The contractor shall procure all necessary permits to carry out their work. They shall also arrange for all tests required on any and all parts of their work by local authorities, paying all regular and proper chargers for same. They shall also obtain all certificates of inspection and approval from all required authorities and the Underwriters. Underwriters' certificates in duplicate shall be furnished to the Department at the completion of the project. Also, the contractor shall furnish two copies of each intermediate Underwriters' inspection report to the Department. All fees and permits required shall be satisfied and obtained by the contractor and the cost shall be included in the contract price.
- B. When the installation is reported in writing by the Contractor to be complete and ready for acceptance, tests and inspection shall be made by the Contractor in the presence of representatives of the Department to ascertain whether it complies with the specifications and Contract, and upon its failure to do so, the Contractor shall at once remedy all defects and shortcomings, and any additional tests that may be required shall be entirely at the Contractor's expense.
- C. This Contractor shall be entirely responsible for all apparatus, equipment, and appurtenances furnished under this Contract in connection with the work, and special care shall be taken to protect all parts thereof in such a manner as may be necessary or as may be directed. Protection

shall include covers, crating, sheds, or other means to prevent dirt, grit, plaster, or other foreign substances from entering the working parts of machinery or equipment. Special care shall be taken to keep all open ends of conduit and other equipment closed while in storage and during the course of installation. Where equipment must be stored outside the building, it shall be totally covered and secured with heavy waterproof tarps and kept dry at all times. Where equipment has been subjected to moisture, it shall be suitably dried out before placed in service. All apparatus, equipment, conduit and other appurtenances shall be stored in areas designated by the Department.

1.4 DEFINITIONS

- A. Approved Equal: The term “approved equal”, “approved”, “equal”, “equivalent”, etc. shall mean equal in all respects in the opinion of the Professional.
- B. As Required: The term "as required" refers to making final connections to and/or coordinating with the appropriate authorities regarding the installation of the indicated equipment.
- C. Contractor: The term "Contractor", "this Contractor" or "Electrical Contractor" when used in the Contract Documents refers to the Contractor responsible for all work specified in Division 26 and as indicated on the Electrical Drawings.
- D. Directed: Terms such as "directed," "requested," "authorized," "selected," and "permitted" when used separately without referencing any authority, shall mean directed by the Professional, requested by the Professional, and similar phrases.
- E. Disconnect: Disconnect electrical service to indicated items. Associated conduit and wire shall be disconnected and removed, complete, back to its source. Where electrical equipment (i.e. generator) is connected to radiator, fuel, and exhaust piping, intake and exhaust ductwork, etc., this Contractor shall disconnect and remove all associated appurtenances, complete, back to their source unless noted otherwise.
- F. Existing to Remain: Protect construction and/or indicated items to remain against damage and soiling during selective demolition. When permitted by the Professional, items may be removed to a suitable, protected storage location during selective demolition and then cleaned and reinstalled in their original locations.
- G. Finished/Unfinished Space: The term “finished space” shall mean areas where drywall is hung and installed with wall coverings and/or painted, floors are polished or coverings are installed on the floor, and the ceiling is plaster/gypsum board and/or suspended A.C.T. The term “unfinished space” refers to any area that does not meet the definition for a “finished space” as specified above. Mechanical rooms, electrical rooms, garages, etc. are typically considered “unfinished spaces”.
- H. Furnish: The term "furnish" when used separately, shall mean to supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation, and similar operations by others.
- I. Indicated: The term "indicated", "shown," "noted," "scheduled," and "specified" refers to graphic representations, notes, or schedules on the Drawings; or to other paragraphs or schedules in the Specifications and similar requirements in the Contract Documents.

- J. Install: The term "install" when used separately, shall mean to mount in place, connect and make operable. Installation operations at the Project site shall include, but not be limited to, the actual unloading, temporary storage, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- K. Provide: The term "provide" when used in these specifications, shall mean to furnish and install, complete and ready for the intended use. See above definitions for additional requirements.
- L. Regulations: The term "regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.
- M. Reinstall: Remove items indicated; clean, service, and otherwise prepare them for reuse; store and protect against damage. Reinstall items in the same locations or in locations indicated.
- N. Remove: Remove and legally dispose of items except those indicated to be reinstalled or salvaged or to remain the Department's property as directed.
- O. Salvage (Turn Over to Department): Items indicated to be salvaged remain the Department's property. Remove, clean, and pack or crate items to protect against damage. Identify contents of containers and deliver to Department's designated storage area.
- P. Subcontractor: The term "Subcontractor" when used in these Contract Documents refers to an experienced installer (i.e. manufacturer, vendor, etc.) whom has successfully completed a minimum of five (5) previous projects similar in size and scope to this Project; being familiar with the special requirements indicated; and having complied with requirements of authorities having jurisdiction. Any reference to, or letting of work contained in these Contract Documents to any Subcontractor does not relieve this Contractor of his/her responsibility for all work, material and equipment indicated in these Contract Documents.
- Q. Work: The term "work" refers to all labor and materials provided by the Contractor and/or Subcontractor to make a complete and operable system.

1.5 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and as indicated below.
 1. Collect Product Data into a single submittal for each element of construction or system. Product Data includes printed information, such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams, and performance curves.
 2. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products that are not required, mark copies to indicate the applicable information. Include the following information:
 - a. Manufacturer's printed recommendations.
 - b. Compliance with trade association standards.
 - c. Compliance with recognized testing agency standards.

- d. Application of testing agency labels and seals.
 - e. Notation of dimensions verified by field measurement.
 - f. Notation of coordination requirements.
3. Do not submit Product Data on the following items and/or systems until compliance with requirements of the Contract Documents has been confirmed. See "Substitutions" article specified elsewhere in Part 1 for the Compliance Report requirements
- B. If the Contractor submits a product of a manufacturer which appears as a second or third name without corresponding catalog numbers and/or the manufacturer is not listed by name, the submittal shall include a Compliance Report. See "Substitutions" article specified elsewhere in Part 1 for the Compliance Report requirements and additional substitution requirements.
- C. All drawings, etc., submitted for approval shall be marked with the name of the project and shall bear the stamp of approval of the Contractor as evidence that the material has been checked by the Contractor. Any drawings, etc., submitted without this stamp of approval will not be considered and will be returned to the Contractor for resubmission.
- D. Additional copies may be required by individual sections of these Specifications.
- E. None of the items throughout the electrical specifications which require a submission and/or review, shall be installed in the work or orders placed for same until final review has been given by the Professional.
- F. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Control" article of this Section.
- G. Selective Demolition
- 1. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut off of electrical service, and details for dust and noise control.
 - a. Coordinate sequencing with construction phasing and Department occupancy as directed.
 - 2. Inventory of items removed and salvaged by the Contractor for the Department for inclusion in the Operation and Maintenance Manuals.
 - 3. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by selective demolition operations.
 - 4. Record drawings at Project closeout according to Division 1 Section "Contract Closeout."

1.6 SUBSTITUTIONS

- A. General: In order to establish standards of quality and performance, all types of materials listed hereinafter by manufacturer's names and/or manufacturer's catalog number shall be provided as specified. If this Contractor desires to substitute an item, he/she shall comply with the following administrative and procedural requirements which are included in this Section to expand the requirements as defined by Part 1 paragraph "Related Documents".

- B. Substitutions will be permitted only on products specified with the phrase “or approved equal”, “or as approved”, “or equal”, “or equivalent”, etc. and the burden shall be upon the bidder to prove such equality. If the Contractor elects to prove such equality, he/she must request the Professional's approval in writing to substitute such item for the specified item, and shall submit supporting data, and samples if required, to permit a fair evaluation of the proposed substitution with respect to quality, serviceability and warranty.
1. Samples: When requested, samples of items that the Contractor proposes to use as substitutions for the specified products/systems shall be submitted as follows.
 - a. A sample of both the specified item and the proposed substitute item shall be submitted simultaneously. The scheduling of the submission of such samples shall be as directed and shall in no way delay the progress of the Project.
 - b. Fixtures shall be submitted complete with lamps and a line cord ready for temporary operation.
 - c. The Professional will assume no responsibility whatsoever for any samples submitted.
- C. When the phrase “or approved equal”, “or as approved”, “or equal”, “or equivalent”, etc. appears and the Contractor desires to furnish equipment of a manufacturer other than that specified or intended, he/she shall include a complete specification of the substituted item, along with each submission copy of shop drawings, indicating the necessary modifications to the substituted product to satisfy the requirements of the Contract Documents.
1. Compliance Report: Along with each submission copy of the product data and/or shop drawing, the manufacturer shall indicate the necessary modifications to the product and/or system to satisfy the requirements of the Contract Documents. Each paragraph including all subparagraphs shall bear the same paragraph number as the contract specification so that a close comparison can be made to the manufacturer specified herein by catalog number(s).
 2. Each paragraph for the substituted product/system shall be identified as follows:
 - a. Comply: The term “comply” shall only be used when the product/system indicated by the paragraph is completely equal in all respects to the type of material used, functionality, programmability, size, accessories to be provided, future capabilities, mounting, etc. to that which was specified. Anything less is not to be considered as complying and shall not be indicated as “Comply”.
 - b. Exception: The term “exception” shall be used when the product/system indicated by the paragraph does not meet the definition of “comply” as indicated above. The manufacturer shall provide a brief, clear and non-technical description of why the product/system does not meet the requirements of the specification and why it is not necessary to provide the specified materials, components, features, etc.
 - c. Deviate: The term “deviate” shall be used when the product/system indicated in the paragraph does not fully comply but the manufacturer is willing to provide all the necessary materials, components, features, accessories, future capabilities, etc. to meet the intent of the Contract Documents as determined by the Professional. The manufacturer shall provide a brief, clear and non-technical description of what additional items are to be provided and how these items affect the product/system.

3. Compliance report may be submitted prior to the submission of the substituted product data and/or shop drawings but the Professional reserves the right to request that certain product data, shop drawings, wiring diagrams, certificates, etc. be included as requested.
- D. All costs involved in changes in the building, to the equipment, to the arrangement of equipment, or to the work performed or to be performed under other sections of the specifications, due to the substitution of equipment in lieu of that shown on the drawings or specified, shall be borne by the Contractor making such substitutions, and shall include, but not necessarily be limited to, costs or fees in connection with resubmission of drawings for approval, if required, by the Authority Having Jurisdiction, local authorities or insuring agencies having jurisdiction over the work.

1.7 REGULATIONS

- A. All laws, ordinances, rules and regulations of public bodies bearing on the conduct of the work are hereby incorporated and made a part of these specifications.
1. Americans with Disabilities Act.
 2. Pennsylvania Uniform Construction Code.
 3. City and Local Codes.
 4. National Fire Protection Association (NFPA), i.e. National Electric Code - NFPA 70, Electrical Safety in the Workplace – NFPA 70E, National Fire Alarm Code – NFPA 72, Life Safety Code - NFPA 101 and Emergency and Standby Power Systems – NFPA 110.
 5. National Electrical Safety Code - ANSI C2.
 6. Department's insuring agency.
 7. International Building Code (IBC)
- B. The Contractor shall comply with all rules, regulations and recommendations of any public utility serving this project.
- C. The entire electrical system shall be installed in accordance with the latest edition of the National Electrical Code, approved by the governmental body having jurisdiction, including amendments thereto.

1.8 DRAWINGS AND SPECIFICATIONS

- A. The drawings are generally diagrammatic and indicative of the work to be installed. Exact locations of equipment and points of termination shall be reviewed with the Professional. Should it be found that any system or equipment cannot be installed as shown on the drawings, the Professional shall be consulted before installing or making changes to the layout.
- B. The drawings and specifications are intended to function as a common set of documents. Anything shown on the drawings but not in the specifications, or mentioned in the specifications and not shown on the drawings, shall be equally binding as if both noted on the drawings and called for in the specifications.
- C. No measurement of a drawing by scale shall be used as a working dimension. Working measurements shall be taken from figured dimensions and through cooperation with all other Contractors.

- D. This Contractor shall carefully examine the Structural, HVAC, Plumbing and Miscellaneous Contract Drawings and Specifications. If any discrepancies occur between the drawings or between the drawings and specifications, the discrepancies shall be reported to the Professional in writing and obtain written instructions as to the manner in which to proceed. No departures from the Contract Drawings shall be made without prior written instructions from the Professional.
- E. All items of labor, material and equipment not specified in detail or shown on the drawings but incidental to or necessary for the complete and proper installation and proper operation of the several branches of the work described herein or reasonably implied in connection therewith, shall be furnished as if called for in detail by the specifications or drawings.

1.9 FAMILIARITY WITH CONTRACT REQUIREMENTS

- A. It is the responsibility of the Contractor, prior to submitting a bid on this Project, to satisfy himself as to the nature and location of the work, the conformation of the ground, soil characteristics, the character, quality and quantity of the materials which will be required, the character of equipment and facilities needed preliminary to and during the prosecution of the work, the general and local conditions, and of all other matters which can in any way affect the work under this Contract.
- B. Failure to make an on-site inspection prior to submitting a bid, or failure to comply with any or all of the above requirements will not relieve this Contractor from the responsibilities of properly estimating the requirements or costs of successful completion of the work nor from the responsibility for the faithful performance of the provisions of this Contract.
- C. The Electrical Contractor shall confer with all other Contractors and shall apply for detailed and specific information regarding the location of all equipment as the final location may differ from that indicated on the drawings. Outlets, equipment or wiring improperly placed because of the Electrical Contractor's failure to obtain this information shall be relocated and reinstalled by the Electrical Contractor without additional expense to the Department.

1.10 COORDINATION DRAWINGS:

- A. Coordination drawings shall be initiated by the contractor responsible for the ductwork installation. That contractor shall indicate, on the mechanical floor plans, equipment and duct locations and dimensions drawn to scale, taking into consideration and incorporating proper clearances. The drawing shall then be given to the contractors installing piping, conduit for the inclusion of their work on the coordination drawing. All discrepancies and conflicts with the architectural layout of the building shall be noted on the coordination drawings. The contractors shall meet as required to resolve discrepancies with ductwork, piping, and conduit prior and to coordinate those elements on the coordination drawing. The contractor who initiated the coordination drawings shall submit them for review. Coordination and installation of any equipment not indicated on the coordination drawing shall be the responsibility of the contractor responsible for that equipment. Any modifications required by any contractor for equipment to be installed that is not shown on the coordination drawing shall be the responsibility of the contractor who failed to indicate that equipment.
 - 1. Planned piping layout, including valve and specialty locations and valve-stem movement.

2. Clearances for installing and maintaining insulation.
 3. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
 4. Equipment and accessory service connections and support details.
 5. Exterior wall and foundation penetrations.
 6. Fire-rated wall and floor penetrations.
 7. Sizes and location of required concrete pads and bases.
 8. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
 9. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
- B. Electronic Files: Provide electronic files of all shop drawings and coordination drawings in Autocad 2010 format or later version unless directed to provide a specific vintage in Division 1. Also provide drawings in a PDF format.
- C. Electrical Maintenance Manual
1. Equipment and Systems: Provide the following information for each piece of equipment, each building operating system, and each electric or electronic system.
 - a. Description: Provide a complete description of each unit and related component parts, including the following:
 - 1) Equipment or system function.
 - 2) Operating characteristics.
 - 3) Limiting conditions.
 - 4) Performance curves.
 - 5) Engineering data and tests.
 - 6) Complete nomenclature and number of replacement parts.
 - b. Manufacturer's Information: For each manufacturer of a component part or piece of equipment, provide the following:
 - 1) Printed operation and maintenance instructions.
 - 2) Assembly drawings and diagrams required for maintenance.
 - 3) List of items recommended to be stocked as spare parts.
 - c. Maintenance Procedures: Provide information detailing essential maintenance procedures, including the following:
 - 1) Routine operations.
 - 2) Troubleshooting guide.
 - 3) Disassembly, repair, and reassembly.
 - 4) Alignment, adjusting, and checking.
 - d. Operating Procedures: Provide information on equipment and system operating procedures, including the following:
 - 1) Startup procedures.
 - 2) Equipment or system break in.

- 3) Routine and normal operating instructions.
- 4) Regulation and control procedures.
- 5) Instructions on stopping.
- 6) Shutdown and emergency instructions.
- 7) Summer and winter operating instructions.
- 8) Required sequences for electric or electronic systems.
- 9) Special operating instructions.

- e. Servicing Schedule: Provide a schedule of routine servicing and lubrication requirements, including a list of required lubricants for equipment with moving parts.
- f. Controls: Provide a description of the sequence of operation and as installed control diagrams by the control manufacturer for systems requiring controls.
- g. Circuit Directories: For electric and electronic systems, provide complete circuit directories of panel boards, including the following:
 - 1) Electric service.
 - 2) Controls.
 - 3) Communication.

- D. In addition to the number of maintenance manuals referenced in the "Related Documents" paragraph, prepare one (1) additional copy to be kept by the Professional.

1.11 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Labels and Listings: "Labels and Listings" for appliances and equipment provided meet the requirements of the Underwriters Laboratories, Inc. (UL), Electrical Testing Laboratories (ETL) and other standards organizations.
- C. Current Models:
 1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
 2. Replacement parts shall be available.
 3. There shall be a permanent service organization maintained or trained by the manufacturer to provide satisfactory service.
- D. Experience: Manufactured items shall have been installed and used, without modification, renovation or repair, on other projects for not less than three years prior to the date of bid opening for this project.
- E. All work shall be installed in a first class, neat and workmanlike manner by mechanics skilled in the trade involved. The quality of workmanship shall be subject to the approval of the Professional. Any work found by the Professional to be of inferior quality and/or workmanship shall be replaced and/or reworked until approval of the Professional is obtained. Any cost involved in obtaining said approval shall be the responsibility of the Electrical Contractor.

1.12 CONTINUITY OF SERVICE

- A. When it becomes necessary to temporarily interrupt electric service to any portion of the buildings, the Contractor shall notify the Department in writing at least seven days in advance to enable necessary arrangements to be made. No interruptions will be permitted without the expressed written permission of the Department.
- B. The existing fire alarm system shall be fully maintained in service during the execution of work under this Contract. The Contractor shall furnish and install, and later remove any temporary equipment, wiring or other appurtenances necessary to provide the continuity of service for the system.

1.13 INSTRUCTIONS TO OPERATING PERSONNEL

- A. The Contractor shall furnish the services of a person, or persons, approved by the Professional and thoroughly familiar with the completed installation to instruct the Department's Operating Personnel in the proper operation of the electrical systems and the proper care of all equipment and apparatus included under this Contract. These services shall be furnished for a minimum of two 8-hour days.
- B. During the instruction period, the Contractor and his approved qualified personnel shall demonstrate to the Department, in the presence of the Professional's representative, the complete operation of the various systems installed under this Contract. Manufacturers' certificates of tests and performance shall be delivered to the Professional and the Department as hereinafter specified with the various systems or equipment.
- C. When instructions are provided under this Contract, the Contractor shall have in his possession three copies of an identifying letter which shall list the names of the Contractor's qualified instruction personnel including manufacturer's representatives and subcontractors that will be giving the instructions. Likewise on this same letter, spaces shall be provided for the Department's personnel who will receive the instructions. After instructions have been given and received for each system, the Contractor's representatives and subcontractors shall sign and date the letter, and the Department's personnel shall also sign and date the letter acknowledging that they have received adequate instructions for operating and maintaining the systems and equipment. One signed copy shall be delivered to the Department, one copy to the Professional, and one copy shall be retained by the Contractor.
- D. In addition to the verbal instructions outlined above, the Contractor and his manufacturers' representatives and subcontractors shall furnish written basic instructions indicating the proper operation of each system and associated equipment. Each manufacturer shall also submit a brochure on his equipment, including instructions on operation, lubrication, recommended spare parts, and instructions on preventative, routine, and breakdown maintenance.
- E. The Contractor shall combine the written instructions and the manufacturers' equipment brochures in complete volumes with hard back binders which shall be turned over to the Department before final acceptance of the Contract work. Unless otherwise directed, three (3) copies of the volumes shall be furnished.
- F. All brochures and formats must be approved by the Professional.

- G. It is the intent that this entire system, with its complement of equipment and auxiliary equipment, operate properly in accordance with the design concept and functional intent. It is also the intent that the Department be given complete instructions for the proper operation and maintenance of the entire system.

1.14 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.15 GUARANTEE/WARRANTY

- A. Written one (1) year full warranty guarantees shall be submitted for the entire electrical installation installed under this project (except for lamps). Where manufacturer's standard guarantee provides for a longer period, the longer period shall apply.
- B. Where defects in the material, equipment and/or workmanship become evident within this guarantee period, the Contractor shall be responsible for replacing such material and equipment with the approved type of new items; and/or correcting the defective workmanship without any costs to the Department.

1.16 SEQUENCING, SCHEDULING AND COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. So connecting raceways, cables, wire ways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Arrange selective demolition so as not to interfere with Department's on site operations.
- D. Coordinate electrical equipment installation with other building components.
- E. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning prior to closing in the building.
- F. Coordinate connecting electrical service to components furnished under other Sections.
- G. Coordinate connecting electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

PART 2 - PRODUCTS

2.1 CONCRETE BASES

- A. Concrete: 4000-psi, 28-day compressive strength

2.2 SLEEVE SEALS

- A. The Contractor shall furnish and install modular wall seals where conduits pass through exterior walls. Seals shall be "Link-Seal" modular wall and casing seal, as manufactured by Thunderline Corporation, or approved equal. Sleeves shall be of appropriate size for the size of conduits to be installed, in accordance with the manufacturer's recommendations. The seal shall be composed of identical solid rubber links, bolted and interlocked to form a belt. As belt bolts are tightened, rubber links form an automatic protective seal. The seal shall be rated for 40 feet of head or 20 psig. Seal shall be capable of absorbing shock transmitted either from changes in internal pipe pressures or from ground disturbances. Seal shall be made of synthetic rubber material especially compounded to resist aging, ozone, sunlight, water, and chemical action, and shall provide low temperature flexibility and resistance to high temperature environments. Bolts and metal parts shall be of carbon steel and zinc phosphate plated to resist corrosion. The seal shall be capable of providing air tightness in above ground installations and hydrostatic sealing in below grade installations. Seal shall be capable of maintaining cathodic protection with Delrin plastic pressure plates. Install seals in accordance with Manufacturer's Bulletin LS-104. Brush underground metal parts with a good grade of mastic before backfill.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.4 MISCELLANEOUS METALS

- A. Steel plates, shapes, bars, and bar grating: ASTM A 36.
- B. Cold Formed Steel Tubing: ASTM A 500.
- C. Hot Rolled Steel Tubing: ASTM A 501.
- D. Steel Pipe: ASTM A 53, Schedule 40, welded.
- E. Fasteners: Zinc coated, type, grade, and class as required.

2.5 MISCELLANEOUS LUMBER

- A. Framing Materials: Standard Grade, light framing size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPA rules, or Number 3

boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP 2, and kiln dried to a moisture content of not more than 19 percent.

- B. Construction Panels: Plywood panels; APA C D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 15/32 inches.

2.6 TOUCHUP PAINT

- A. For Equipment: Provided by equipment manufacturer and selected to match equipment finish.
- B. For Nonequipment Surfaces: Matching type and color of undamaged, existing adjacent finish.
- C. For Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

2.7 REPAIR MATERIALS

- A. Use repair materials identical to existing materials. Where identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible. Use materials whose installed performance equals or surpasses that of existing materials.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. This Contractor shall expedite the work for a specific area, section or part of the Project to make provision for, or protect equipment or to permit the installation of another part of the work.
- B. All materials and equipment supplied by this Contractor shall be new, of the best of their respective kinds, without imperfections and blemishes, and shall be protected from the elements prior to installation.
- C. All conduits, wire, cable, wiring devices and equipment shall be installed in such a manner as to preserve access to any existing equipment or to any new equipment installed under this specification or under other specifications or contracts for this Project and with sufficient space provided for proper operation and maintenance.
- D. The drawings are generally indicative of the work to be installed but do not indicate all bends, fittings, boxes, etc., which may be required. The Contractor shall carefully investigate the structural and furnish conditions affecting his work, arrange his work accordingly, and furnish such fittings as may be required to meet such conditions.
- E. This Contractor shall coordinate his work with other trades so that all work may be installed in the most direct manner and so that interference between piping, ducts, equipment, architectural or structural features will be avoided. In cases of interference, conflicts, or fouling results, the Professional shall decide which work is to be relocated, regardless of which was installed first. Such relocation shall be at no additional expense to the Department.

- F. All materials and equipment installed by the Contractor shall be firmly supported and secured to the building structure/construction as required.
- G. Scaffolding with ladders shall be furnished and erected, where required for the proper installation of wiring, equipment and fixtures.

3.2 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in other Specification Divisions and approved product data and shop drawings for rough-in requirements.

3.3 ELECTRICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:
 - 1. Coordinate electrical systems, equipment, and materials installation with other building components.
 - 2. Verify all dimensions by field measurements.
 - 3. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.
 - 4. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
 - 5. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
 - 6. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
 - 7. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Professional.
 - 8. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
 - 9. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
 - 10. Install systems, materials, and equipment giving right of way priority to systems required to be installed at a specified slope.

B. Performance of Equipment

1. All materials, equipment and appurtenances of any kind, shown on the drawings, hereinafter specified or required for the completion of the Project in accordance with the intent of these specifications, shall be completely satisfactory and acceptable in operation, performance, and capacity. No approval either in written or verbal of any drawings, descriptive data, or samples of such material, equipment and/or appurtenances shall relieve this Contractor of his responsibility to turn over the same to the Department in perfect working order at the completion of the Project.
2. Any material, equipment or appurtenances, the operation, capacity or performance of which does not comply with the drawings and/or specification requirements or which is not new or which is damaged prior to acceptance by the Department will be held to be defective material and shall be removed and replaced with the proper acceptable materials, equipment and/or appurtenances or put in proper acceptable working order, satisfactory to the Professional with no additional expense to the Department.
3. All auxiliary systems specified herein such as the fire alarm system or other similar systems shall be furnished by manufacturers who have been regularly engaged in the manufacture of these products for a period of not less than five (5) years. This Contractor shall deliver to the Professional, prior to final payment, a statement from the manufacturer or his authorized representative, certifying that the equipment has been inspected by him and found to be properly installed and functioning satisfactorily. Installation, final connections and testing of such systems shall be performed under the direct supervision of competent authorized service engineers who shall be in the employ of the respective equipment manufacturer. Any and all expenses incurred by these equipment manufacturer's representatives shall be borne by the Contractor.
4. All details of the installation of all equipment shall be electrically and mechanically correct. All equipment shall operate without objectional noise or vibration should be produced and transmitted to occupied portions of the building by apparatus, conduit or other parts of a system, any corrections to eliminate noise and vibration shall be at no expense to the Department.

3.4 CUTTING AND PATCHING

- A. General: Perform cutting and patching in accordance with Part 1 paragraph "Related Documents." In addition to the requirements referenced in the "Related Documents" paragraph, the following requirements apply:
 1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
 - a. Uncover Work to provide for installation of ill timed Work.
 - b. Remove and replace defective Work.
 - c. Remove and replace Work not conforming to requirements of the Contract Documents.
 - d. Install equipment and materials in existing structures.
 - e. Upon written instructions from the Professional, uncover and restore Work to provide for Professional observation of concealed Work.

2. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.
3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
5. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
6. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

B. Cutting, Patching, and Finishing (Existing Building)

1. Electrical Contractor shall be responsible for all cutting, patching, and finishing of existing construction for the proper installation of all electrical equipment and materials to be installed in the existing portion of this project. This will also be required for the removal of the existing equipment and materials. All cutting shall be kept to an absolute minimum consistent with the requirements of the project. Cutting, patching and finishing shall be done by workmen skilled in this type of work. All patching shall be done utilizing materials of the same quality and texture as the adjacent undisturbed areas perfectly and to the satisfaction of the Professional.
 - a. Cutting: Cut and remove existing construction only to the extent required by new Work and as indicated. Use methods required to complete Work within limitations of governing regulations and as follows:
 - 1) 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. To minimize disturbance of adjacent surfaces, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
 - 2) Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 - 3) 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 fire suppression devices during flame cutting operations.
 - 4) Maintain adequate ventilation when using cutting torches.
 - 5) Cut concrete and masonry at junctures with construction to remain, using power driven masonry saw or hand tools; do not use power driven impact tools.
 - b. Patching: Return elements of construction and surfaces to remain to condition existing before start of cutting operations.
 - c. Painting
 - 1) All surfaces to be painted shall receive an undercoat 24 hours before the final coat is applied. Undercoats which show lumps or rough areas shall be smoothed with fine sandpaper or steel wool and dusted off before the final

coat is applied. Final coat shall be solid, even color, free of lumps, drops, sags, run brush marks, laps, or other defects, finished to a line where they adjoin other colors or unpainted surfaces.

- 2) Drop cloths shall be used to protect floors and all other work from damage. Any covering temporarily removed from any part of the work or finish shall be promptly replaced and any damage from neglect to so protect all surfaces shall be good at the Contractor's expense.
 - 3) Paint color shall match adjoining surfaces as closely as possible and to the satisfaction of the Professional.
2. No cutting shall be done which may affect the building structurally or architecturally including building systems without first securing the approval of the Professional. Cutting shall be accomplished in such a manner as not to cause damage to the building or leave unsightly surfaces which cannot be concealed by plates, escutcheons, or other construction. Where unsightly conditions are caused, the Contractor shall be required, at his own expense, to repair the damaged areas.
 3. Cutting of the construction excessively or carelessly done shall be repaired by this Contractor to match the original work and to the satisfaction of the Professional who will make the final decision with respect to excessive or careless cutting work.
 4. This Contractor shall seal all openings he has made in plenum spaces, fire rated floors, ceilings or partitions after his work has been installed. The material used for sealing the openings shall have a fire rating equal to or greater than the rating of the floor, ceiling or partition material. Openings shall be suitably treated to prevent passage of stray light, air or sound.
 5. Where present equipment is removed and unused openings remain in walls, floors, partitions, etc., this Contractor shall properly patch all such openings. All patching and repairing shall be done by workmen skilled by this type or work and shall match present or new finishes.
 6. All holes or openings for the passage of conduit to be put in existing concrete shall be bored.
 7. Cutting, patching, and repairing of openings in the existing exterior walls and roof shall be by this Contractor.

3.5 PROTECTION OF WORK, MATERIALS, AND EQUIPMENT

- A. This Contractor shall effectually protect at his own expense, all existing facilities and such of his new work, materials or equipment as is liable to injury during the construction period. All openings in to any part of the conduit system as well as all associated fixtures, equipment, etc. both before and after being set in place shall be securely covered or otherwise protected to prevent obstruction, damage, or injury due to carelessly or maliciously dropped tools or materials, grit, dirt moisture, water or any foreign matter. This Contractor shall be held responsible for all damage so done, until his work is fully accepted by the Professional. Conduit ends shall be covered with capped bushings.
- B. All surfaces, either finished or in preparation for finishing or finish material application, shall be protected against damage from painting, welding, cutting, burning, soldering or similar construction functions. The protection shall be accomplished by care in operations, covering and shielding. Special care shall be directed to exposed finished masonry, metal or wood surfaces and painted surfaces. Corrective measures required shall be accomplished by the trade

which made the original installation and shall be at the expense of the Contractor causing the damage with no cost to the Department.

- C. Any damage caused by neglect on the part of this Contractor or his representative, or by the elements due to neglect on the part of this Contractor or his representatives, either to the existing work, or to his work or to the work of any other Contractor, shall be repaired at his expense to the Professional's satisfaction.

3.6 CONCRETE BASES

- A. General: Install concrete pads and bases as indicated.
- B. Forms and Reinforcing Materials
 1. Form concrete pads with framing lumber with form release compounds. Chamfer top edge and corners of pad. Anchor or key to floor slab.
 2. Install reinforcing bars where required, tied to frame, and place anchor bolts and sleeves to facilitate securing units.
- C. Mounting: Anchor electrical equipment and other system components on concrete housekeeping bases. Provide anchorage according to manufacturer's written instructions, unless otherwise indicated.
 1. Concrete Pad: Housekeeping bases shall be 4" high with 1" chamfer edges minimum and shall extend 4" beyond the edge of the electrical equipment on all accessible sides unless indicated otherwise. Coordinate size of equipment with actual unit size before proceeding with any formwork.
 2. Clearance: Maintain minimum workspace around components according to manufacturer's Shop Drawings and National Electrical Code.
 3. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
- D. Concrete: Place concrete and allow to cure before installation of units. Use Portland cement that conforms to ASTM C 150, 4000 psi, 28-day compressive strength, and normal weight aggregate.

3.7 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.8 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7.

3.9 CLEAN-UP

- A. Daily, and when directed by the Professional, the Electrical Contractor shall remove all waste and debris resulting from his work.
- B. Upon completion of his work and when directed by the Professional, the Electrical Contractor shall remove all dirt, foreign materials, stains and fingerprints from all equipment, fixtures, panels, plates, etc., installed under this contract. Internal areas of all equipment must be cleaned of all construction dust etc., prior to pre-final and/or final inspection.
 - 1. Clean paint, varnish spots and stains caused by finishing materials used by this Contractor from all walls, floors, trim, glass, hardware, fixtures, masonry or any other surface that is damaged by this Contractor's work.
 - 2. Do not use solvents, that would remove or damage the finish of the finish hardware or other factory-finished materials. If damage occurs, the affected materials shall be returned to the factory for refinishing at no expense to the Department.
 - 3. Repair all finishes damaged by this Contractor.

END OF SECTION

SECTION 260519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.
- B. Additional Related Sections Include:
 - 1. Division 26 Section "Commissioning of Electrical" for commissioning of systems and equipment.

1.2 SUMMARY

- A. Section Includes:
 - 1. Copper building wire rated 600 V or less.
 - 2. Metal-clad cable, Type MC, rated 600 V or less.
 - 3. Connectors, splices, and terminations rated 600 V and less.

1.3 DEFINITIONS

- A. RoHS: Restriction of Hazardous Substances.
- B. VFC: Variable-frequency controller.

1.4 SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: Indicate type, use, location, and termination locations.
- C. Qualification Data: For manufacturer's authorized service representative.
- D. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. RoHS compliant.
 - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- C. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- D. Conductor Insulation:
 - 1. Type THHN and Type THWN-2: Comply with UL 83.
 - 2. Type XHHW-2: Comply with UL 44.

2.2 METAL-CLAD CABLE, TYPE MC

- A. Used only for fixture whips.
- B. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
- C. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. Comply with UL 1569.
 - 3. RoHS compliant.
 - 4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

- D. Circuits:
 - 1. Single circuit and multicircuit with color-coded conductors.
 - 2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.
- E. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- F. Ground Conductor: Insulated.
- G. Conductor Insulation:
 - 1. Type TFN/THHN/THWN-2: Comply with UL 83.
 - 2. Type XHHW-2: Comply with UL 44.
- H. Armor: Aluminum, interlocked.
- I. Jacket: PVC applied over armor.

2.3 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.
- C. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
 - 1. Material: Copper.
 - 2. Type: One or Two hole with standard or long barrels.
 - 3. Termination: Compression or Crimp.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- D. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.

- E. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
- B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- D. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway, Metal-clad cable, Type MC (Maximum 6'-0" Length).
- F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- G. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- H. VFC Output Circuits: Type XHHW-2 in metal conduit.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.

2. After installing conductors and cables and before electrical circuitry has been energized, test conductors feeding the following critical equipment and services for compliance with requirements:
 - a. Fire pump.
 - b. Stair pressurization fans.
 3. Perform each of the following visual and electrical tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - b. Test bolted connections for high resistance using one of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - 3) Thermographic survey.
 - c. Inspect compression-applied connectors for correct cable match and indentation.
 - d. Inspect for correct identification.
 - e. Inspect cable jacket and condition.
 - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
 - g. Continuity test on each conductor and cable.
 - h. Uniform resistance of parallel conductors.
- E. Cables will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports to record the following:
1. Procedures used.
 2. Results that comply with requirements.
 3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION

SECTION 260526

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.
- B. Additional Related Sections Include:
 - 1. Division 26 Section "Commissioning of Electrical" for commissioning of systems and equipment.

1.2 SUMMARY

- A. Section includes grounding and bonding systems and equipment.
- B. Section includes grounding and bonding systems and equipment, plus the following special applications:
 - 1. Ground bonding common with lightning protection system.
 - 2. Foundation steel electrodes.
 - 3. Emergency power system grounding.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Coordination Drawings: Plans showing dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
 - 1. Grounding arrangements and connections for separately derived systems.
- C. Qualification Data: For testing agency and testing agency's field supervisor.
- D. Field quality-control reports.
- E. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

- a. Plans showing as-built, dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:

- 1) Grounding arrangements and connections for separately derived systems.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Certified by NETA.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.3 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

- C. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.
- D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- F. Conduit Hubs: Mechanical type, terminal with threaded hub.
- G. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt or socket set screw.
- H. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- I. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.
- J. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.
- K. Straps: Solid copper, copper lugs. Rated for 600 A.
- L. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.
- C. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING SEPARATELY DERIVED SYSTEMS

- A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
 - 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

3.4 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- C. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- D. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- E. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.
- F. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
 2. Make connections with clean, bare metal at points of contact.
 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections with the assistance of a factory-authorized service representative.
- C. Tests and Inspections:
 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
- D. Grounding system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. Report measured ground resistances that exceed the following values:
 1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
 2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.

- G. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Professional promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 260529

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.
- B. Additional Related Sections Include:
 - 1. Division 26 Section "Commissioning of Electrical" for commissioning of systems and equipment.

1.2 SUMMARY

- A. Section Includes:
 - 1. Steel slotted support systems.
 - 2. Aluminum slotted support systems.
 - 3. Nonmetallic slotted support systems.
 - 4. Conduit and cable support devices.
 - 5. Support for conductors in vertical conduit.
 - 6. Structural steel for fabricated supports and restraints.
 - 7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
 - 8. Fabricated metal equipment support assemblies.

1.3 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.

- i. Brackets.
 2. Include rated capacities and furnished specialties and accessories.
 - B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.
 1. Hangers. Include product data for components.
 2. Slotted support systems.
 3. Equipment supports.
 4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Suspended ceiling components.
 2. Ductwork, piping, fittings, and supports.
 3. Structural members to which hangers and supports will be attached.
 4. Size and location of initial access modules for acoustical tile.
 5. Items penetrating finished ceiling, including the following:
 - a. Luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Projectors.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional, as defined in Section 014000 "Quality Requirements," to design hanger and support system.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame Rating: Class 1.
 2. Self-extinguishing according to ASTM D 635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.

1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 2. Material for Channel, Fittings, and Accessories: Galvanized steel or Plain steel.
 3. Channel Width: Selected for applicable load criteria.
 4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: Stainless-steel springhead type.
 7. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
1. NECA 1.
 2. NECA 101
 3. NECA 102.

4. NECA 105.
 5. NECA 111.
- B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
 - C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
 - D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
 - E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps.
 - F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, according to NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Expansion anchor fasteners.
 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.

6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
 7. To Light Steel: Sheet metal screws.
 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base as follows:
 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Section 099123 "Interior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 260533

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Metal wireways and auxiliary gutters.
3. Surface raceways.
4. Boxes, enclosures, and cabinets.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for firestopping at conduit and box entrances.
2. Section 280528 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.
3. Division 26 Section "Commissioning of Electrical" for commissioning of systems and equipment.

1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. IMC: Intermediate metal conduit.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

- C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of conduit groups with common supports.
 - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- D. Qualification Data: For professional.
- E. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Metal Conduit:

- 1. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 2. GRC: Comply with ANSI C80.1 and UL 6.
- 3. ARC: Comply with ANSI C80.5 and UL 6A.
- 4. IMC: Comply with ANSI C80.6 and UL 1242.
- 5. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
 - a. Comply with NEMA RN 1.
 - b. Coating Thickness: 0.040 inch, minimum.
- 6. EMT: Comply with ANSI C80.3 and UL 797.
- 7. FMC: Comply with UL 1; zinc-coated steel
- 8. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings:

- 1. Comply with NEMA FB 1 and UL 514B.
- 2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 3. Fittings, General: Listed and labeled for type of conduit, location, and use.
- 4. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
- 5. Fittings for EMT:
 - a. Material: Steel or die cast.
 - b. Type: Compression.
- 6. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
- 7. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

- C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1, Type 3R unless otherwise indicated, and sized according to NFPA 70.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- C. Wireway Covers: Screw-cover type unless otherwise indicated.
- D. Finish: Manufacturer's standard enamel finish.

2.3 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Prime coated, ready for field painting.

2.4 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- D. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- E. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- F. Gangable boxes are allowed.

- G. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 or Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: GRC.
 - 2. Concealed Conduit, Aboveground: EMT.
 - 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT.
 - 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 - 3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 - 6. Damp or Wet Locations: GRC.
 - 7. Boxes and Enclosures: NEMA 250, Type 1.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 - 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 - 3. EMT: Use setscrew or compression, steel or cast-metal fittings. Comply with NEMA FB 2.10.

4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Install surface raceways only where indicated on Drawings.

3.2 INSTALLATION

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

B. Do not fasten conduits onto the bottom side of a metal deck roof.

C. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

D. Complete raceway installation before starting conductor installation.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

G. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.

H. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

I. Support conduit within 12 inches of enclosures to which attached.

J. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.

2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.

4. Do not embed threadless fittings in concrete unless specifically approved by Professional for each specific location.

5. Change from ENT to GRC before rising above floor.

K. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for raceways.

2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

- L. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- M. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- N. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- O. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- P. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- Q. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- R. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- S. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- T. Surface Raceways:
 - 1. Install surface raceway with a minimum 2-inch radius control at bend points.
 - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- U. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- V. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service raceway enters a building or structure.
 - 3. Conduit extending from interior to exterior of building.
 - 4. Conduit extending into pressurized duct and equipment.

5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
 6. Where otherwise required by NFPA 70.
- W. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- X. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- Y. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- Z. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- AA. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- BB. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- CC. Locate boxes so that cover or plate will not span different building finishes.

- DD. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- EE. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- FF. Set metal floor boxes level and flush with finished floor surface.
- GG. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.4 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 260543

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks.
 - 2. Handholes and boxes.
 - 3. Manholes.

1.3 DEFINITION

- A. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Duct-bank materials, including separators and miscellaneous components.
 - 2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 3. Accessories for manholes and handholes.
 - 4. Warning tape.
- B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Reinforcement details.
 - 3. Frame and cover design and manhole frame support rings.
 - 4. Ladder details.
 - 5. Grounding details.
 - 6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
 - 7. Joint details.

- C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Cover design.
 - 3. Grounding details.
 - 4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
- D. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
 - 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
 - 2. Drawings shall be signed and sealed by a qualified professional engineer.
- E. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.
- F. Qualification Data: For professional engineer and testing agency.
- G. Source quality-control test reports.
- H. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Comply with ANSI C2.
- C. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer and at a site approved by the university to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

1.7 COORDINATION

- A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

- B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - 1. A.C. Miller Concrete Products.
 - 2. By-Crete Precast Products
 - 3. Lakelands Concrete Products.
 - 4. Monarch Precast Concrete Corp.
 - 5. Rotondo Precast Company.
 - 6. Zeiser Wilbert Vault Inc.
- B. Comply with ASTM C 858 for design and manufacturing processes.
- C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
 - 1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron or steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 - 2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 3. Cover Legend: Molded lettering, "ELECTRIC.", "DATA." Or "TELEPHONE." As indicated for each service.
 - 4. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.

5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - a. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
6. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

2.3 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. CDR Systems Corporation.
 - d. NewBasis.
 - e. Quazite, Strongwell Lenoir City Division

2.4 PRECAST MANHOLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
 1. A.C. Miller Concrete Products.
 2. By-Crete Precast Products
 3. Lakelands Concrete Products.
 4. Monarch Precast Concrete Corp.
 5. Rotondo Precast Company.
 6. Zeiser Wilbert Vault Inc.
- B. Comply with ASTM C 858, with structural design loading as specified in Part 3 "Underground Enclosure Application" Article and with interlocking mating sections, complete with accessories, hardware, and features.

1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
- C. Concrete Knockout Panels: 1-1/2 to 2 inches thick, for future conduit entrance and sleeve for ground rod.
- D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.5 UTILITY STRUCTURE ACCESSORIES

- A. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
 1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 29 inches.
 - a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
 2. Cover Legend: Cast in. Selected to suit system.
 - a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
 - b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.
 - c. Legend: "SIGNAL" for communications, data, and telephone duct systems.
 3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
 - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387, Type M, may be used.
- B. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.
- C. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch diameter eye, and 1-by-4-inch bolt.

1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.
- D. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- diameter eye, rated 2500-lbf minimum tension.
- E. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
 1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.
- F. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.
 1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.
- G. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.
- H. Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.
 1. Stanchions: T-section or channel; 2-1/4-inch nominal size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.
 2. Arms: 1-1/2 inches wide, lengths ranging from 3 inches with 450-lb minimum capacity to 18 inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
 3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
- I. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
- J. Fixed Manhole Ladders: Arranged for attachment to wall and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from hot-dip galvanized steel.
- K. Cover Hooks: Heavy duty, designed for lifts 60 lbf and greater]. Two required.

2.6 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.
- B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 1. Tests of materials shall be performed by an independent testing agency.

2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-80 or EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.
- B. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-80 or EPC-40-PVC in concrete-encased duct bank, unless otherwise indicated.
- C. Underground Ducts Crossing Driveways and Roadways: RNC, NEMA Type EPC-80-PVC, encased in reinforced concrete.

3.2 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:
 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 or Polymer concrete units, SCTE 77, Tier 8 structural load rating.
- B. Manholes: Precast concrete.
 1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.

3.3 EARTHWORK

- A. Excavation and Backfill: Comply with Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Sections "Turf and Grasses" and "Plants."
- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.4 DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
- B. Where ductbanks cross roads, 2" diameter round brass tags center stamped "ELECTRIC" with the manhole or handhole designation stamped above and below shall be permanently embedded into the face of the curbs at each end of the crossing directly above the ductbank. Manhole designations shall be oriented in the direction of the manholes. Brass tag lettering shall be 3/16" high.
- C. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.
- D. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- E. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
 - 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- F. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical."
- G. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- H. Pulling Cord: Install 100-lbf- test nylon cord in ducts, including spares.

I. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
6. Depth: Install top of duct bank at least 36 inches below finished grade in all areas, unless otherwise indicated.
7. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
8. Warning Tape: Bury warning tape above the buried conduits 6-8" below finished grade. The tape shall not be less than 6" wide by 4 mils thick and all tapes printed with black ink on APWA (American Public Works Association) approved colors to meet or exceed industry standards, and include words "CAUTION BURIED" at start of legend. Refer to chart below for wording and colors of warning tape for specific systems. All warning tape shall have a detectable metallic strip and not be broken the length of the duct bank. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

CAUTION BURIED CATV LINE	Orange
CAUTION BURIED COMMUNICATION LINE	Orange
CAUTION BURIED ELECTRIC LINE	Red
CAUTION BURIED FIBER OPTIC CABLE	Orange
CAUTION BURIED HIGH VOLTAGE	Red
CAUTION BURIED TELEPHONE LINE	Orange

3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891, unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
3. Install handholes with bottom below the frost line.
4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
5. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

D. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

E. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

- F. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 07 Section "Bituminous Dampproofing." After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
- G. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
- H. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
- I. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- J. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.
- D. Install handholes and boxes with bottom below the frost line.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
- F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.7 GROUNDING

- A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
 - 2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
 - 3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.9 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION

SECTION 260544

SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.
2. Division 26 Section "Commissioning of Electrical" for commissioning of systems and equipment.

1.3 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- E. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized sheet steel.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Stainless steel.
 - 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION

SECTION 260553

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.
- B. Additional Related Sections Include:
 - 1. Division 26 Section "Commissioning of Electrical" for commissioning of systems and equipment.

1.2 SUMMARY

- A. Section Includes:
 - 1. Color and legend requirements for raceways, conductors, and warning labels and signs.
 - 2. Labels.
 - 3. Bands and tubes.
 - 4. Tapes and stencils.
 - 5. Tags.
 - 6. Signs.
 - 7. Cable ties.
 - 8. Paint for identification.
 - 9. Fasteners for labels and signs.

1.3 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.
- B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.
- D. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Comply with NFPA 70E and Section 260574 "Overcurrent Protective Device Arc-Flash Study" requirements for arc-flash warning labels.
- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 600 V or Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.
- B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
 - 1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - 3. Color for Neutral: White or gray.
 - 4. Color for Equipment Grounds: Green.
- C. Warning Label Colors:
 - 1. Identify system voltage with black letters on an orange background.

- D. Warning labels and signs shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
- E. Equipment Identification Labels:
 - 1. Black letters on a white field.

2.3 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
- B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.
- C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, polyester or vinyl flexible label with acrylic pressure-sensitive adhesive.
 - 1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
 - 2. Marker for Labels: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 - 3. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Polyester or Vinyl, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
 - 1. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches for raceway and conductors.
 - b. 3-1/2 by 5 inches for equipment.
 - c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

- A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.
- B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

2.5 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.
- C. Tape and Stencil: 4-inch-wide black stripes on 10-inch centers placed diagonally over orange background and is 12 inches wide. Stop stripes at legends.
- D. Floor Marking Tape: 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

2.6 SIGNS

- A. Laminated Acrylic or Melamine Plastic Signs:
 - 1. Engraved legend.
 - 2. Thickness:
 - a. For signs up to 20 sq. in., minimum 1/16 inch thick.
 - b. For signs larger than 20 sq. in., 1/8 inch thick.
 - c. Engraved legend with black letters on white face.
 - d. Self-adhesive.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black, except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 Deg F according to ASTM D 638: 7000 psi.

3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
 1. Secure tight to surface of conductor, cable, or raceway.
- H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer or load shedding.
- K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- L. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
 1. "EMERGENCY POWER."
 2. "POWER."
- M. Vinyl Wraparound Labels:
 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- N. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.
- O. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.
- P. Self-Adhesive Labels:
 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
- Q. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- R. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.
- S. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- T. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
 1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

- U. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- V. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.
- W. Nonmetallic Preprinted Tags:
 - 1. Place in a location with high visibility and accessibility.
 - 2. Secure using general-purpose cable ties.
- X. Laminated Acrylic or Melamine Plastic Signs:
 - 1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
 - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.
- Y. Cable Ties: General purpose, for attaching tags, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels or vinyl tape applied in bands.
 - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- D. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
 - 1. "EMERGENCY POWER."
 - 2. "POWER."
- E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels or self-adhesive wraparound labels or snap-around labels or snap-around color-coding bands or self-adhesive vinyl tape to identify the phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- F. Auxiliary Electrical Systems Conductor Identification: Marker tape or Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
- G. Workspace Indication: Apply floor marking tape or tape and stencil to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- H. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.
1. Apply to exterior of door, cover, or other access.
 2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
 - a. Power-transfer switches.
 - b. Controls with external control power connections.
- J. Arc Flash Warning Labeling: Self-adhesive labels.
- K. Operating Instruction Signs: Laminated acrylic or melamine plastic signs.
- L. Emergency Operating Instruction Signs: Laminated acrylic or melamine plastic signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer or load shedding.
- M. Equipment Identification Labels:
1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
 2. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a self-adhesive, engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Switchgear.
 - e. Switchboards.
 - f. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.

- g. Emergency system boxes and enclosures.
- h. Motor-control centers.
- i. Enclosed switches.
- j. Enclosed circuit breakers.
- k. Enclosed controllers.
- l. Variable-speed controllers.
- m. Power-transfer equipment.
- n. Battery racks.
- o. Power-generating units.
- p. Monitoring and control equipment.

END OF SECTION

SECTION 260573

OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.
 - 1. Coordination of series-rated devices is not permitted.

1.3 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Study and Equipment Evaluation Reports.
 - 3. Coordination-Study Report.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For coordination-study specialist.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

1.5 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

- B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:
 - 1. SKM Systems Analysis, Inc.
 - 2. Approved Equal.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
 - 1. Optional Features:
 - a. Arcing faults.
 - b. Simultaneous faults.
 - c. Explicit negative sequence.
 - d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
 - 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

- A. Gather and tabulate the following input data to support coordination study:
 - 1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Impedance of utility service entrance.
 - 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Generator kilovolt amperes, size, voltage, and source impedance.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - f. Motor horsepower and code letter designation according to NEMA MG 1.
 - 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.
 - f. Special overcurrent protective device settings or types stipulated by utility company.
 - g. Time-current-characteristic curves of devices indicated to be coordinated.
 - h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.

- i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
- j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
 1. Switchgear and switchboard bus.
 2. Distribution panelboard.
 3. Branch circuit panelboard.
- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141 and IEEE 242.
 1. Transformers:
 - a. ANSI C57.12.10.
 - b. ANSI C57.12.22.
 - c. ANSI C57.12.40.
 - d. IEEE C57.12.00.
 - e. IEEE C57.96.
 2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
 3. Low-Voltage Fuses: IEEE C37.46.
- E. Study Report:
 1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
 2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.
- F. Equipment Evaluation Report:
 1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.

3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
 3. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 141 recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.
- E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - c. Fuse-current rating and type.
 - d. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 - a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.
- G. Completed data sheets for setting of overcurrent protective devices.

END OF SECTION

SECTION 260923

DIGITAL LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUBMITTALS

- A. Product Data: Include dimensions and data on features, components, and ratings for lighting control devices.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
 - 1. Lighting plan showing location, orientation, and coverage area of each sensor.
 - 2. Interconnection diagrams showing field-installed wiring.
- C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- D. Operation and Maintenance Data: For each type of lighting control device to include emergency, operation, and in maintenance manuals specified.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for their indicated use and installation conditions by a testing agency acceptable to authorities having jurisdiction.
- B. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.
- C. Comply with NFPA 70.

1.4 COORDINATION

- A. Coordinate features of devices specified in this Section with systems and components specified in other Sections to form an integrated system of compatible components. Match components and interconnections for optimum performance of specified functions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal as approved by the Professional:
1. Watt Stopper (The).
 2. Lutron
 3. Acuity Controls

2.2 SYSTEM DESCRIPTION & OPERATION

- A. The Lighting Control and Automation system as defined under this section covers the following equipment:
1. Digital Room Controllers – Self-configuring, digitally addressable one, two or three relay controllers with 0-10 volt or forward phase control dimming outputs.
 2. Digital Occupancy Sensors – Self-configuring, digitally addressable and calibrated occupancy sensors with display and two-way active infrared (IR) communications.
 3. Digital Switches – Self-configuring, digitally addressable pushbutton switches, dimmers, and scene switches with two-way active infrared (IR) communications.
 4. Configuration Tools – Handheld remote for room configuration provides two way infrared (IR) communications to digital devices and allows complete configuration and reconfiguration of the device / room from up to 30 feet away. Unit to have Organic LED display, simple pushbutton interface, and allow bi-directional communication of room variables and occupancy sensor settings. Computer software also customizes room settings.

2.3 NON-DIGITAL WALL SWITCH OCCUPANCY SENSOR SWITCH

- A. Wall switch sensors shall be capable of detection of occupancy at desktop level up to 300 square feet, and gross motion up to 1000 square feet.
- B. Wall switch sensors shall accommodate loads from 0 to 800 watts at 120 volts; 0 to 1200 watts at 277 volts and shall have 180° coverage capability.
- C. Wall switch products shall utilize Zero Crossing Circuitry which increases relay life, protects from the effects of inrush current, and increases sensor's longevity.
- D. Wall switch sensors shall have no leakage current to load, in manual or in Auto/Off mode for safety purposes and shall have voltage drop protection.
- E. Where specified, wall switch sensors shall provide a field selectable option to convert sensor operation from automatic-ON to manual-ON. Default shall be manual on, automatic off.
- F. Passive infrared sensors shall utilize Pulse Count Processing and Detection Signature Processing to respond only to those signals caused by human motion.

- G. Passive infrared sensors shall provide high immunity to false triggering from RFI (hand-held radios) and EMI (electrical noise on the line).
 - 1. PW IR Range On Axis: 525 SqFt., LightOutput 1FCD: Auto-ON to 50, Load: 0-1000 E 1/6 hp @ 120VAC, 0-1200 W 1/6 hp @ 277VAC, 0-1500 W 1/6 hp @ 347VAC, Response Time: 3 to 30 minutes, Volts: 120/277VAC, 50/60Hz, 347VAC 50/60Hz
- H. Passive infrared sensors shall have a multiple segmented Fresnel lens, in a multiple-tier configuration, with grooves-in to eliminate dust and residue build-up.
- I. Dual technology sensors shall be wall mounted in such a way as to minimize coverage in unwanted areas.
- J. Dual technology sensors shall consist of passive infrared and ultrasonic technologies for occupancy detection. Products that react to noise or ambient sound shall not be considered.
 - 1. DW IR Range On Axis: 525 SqFt., LightOutput 1FCD: Auto-ON to 50, Ultrasonic 20' x 20', Load: 0-1000 E 1/6 hp @ 120VAC, 0-1500 W 1/6 hp @ 277VAC, 0-1500 W 1/6 hp @ 347VAC, Response Time: 3 to 30 minutes, Volts: 120/277VAC, 50/60Hz, 347VAC 50/60Hz
- K. Ultrasonic sensors shall utilize Advanced Signal Processing to adjust the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled space.
- L. Ultrasonic operating frequency shall be crystal controlled at 25 kHz within $\pm 0.005\%$ tolerance, 32 kHz within $\pm 0.002\%$ tolerance, or 40 kHz $\pm 0.002\%$ tolerance to assure reliable performance and eliminate sensor cross-talk. Sensors using multiple frequencies are not acceptable.
- M. All sensors shall be capable of operating normally with solid state lighting loads.
- N. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.
- O. All sensors shall have readily accessible, user adjustable settings for time delay and sensitivity. Settings shall be located on the sensor (not the control unit) and shall be recessed to limit tampering.
- P. In the event of failure, a bypass manual override shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly or control shall divert to a wall switch until sensor is replaced. This control shall be recessed to prevent tampering.
- Q. All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation.
- R. All sensors shall be dual technology type and have UL rated, 94V-0 plastic enclosures.

2.4 DIGITAL CEILING MOUNTED OCCUPANCY SENSOR SYSTEM

- A. Wall or ceiling mounted (to suit installation) dual technology digital (passive infrared and ultrasonic) occupancy sensor. Furnish the Company's system which accommodates the square-foot coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors and accessories which suit the lighting and electrical system parameters.
- B. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
 - 1. Digital calibration and pushbutton programming for the following variables:
 - a. Sensitivity – 0-100% in 10% increments
 - b. Time delay – 1-30 minutes in 1 minute increments
 - c. Test mode – Five second time delay
 - d. Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
 - e. Walk-through mode
 - f. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
 - 2. One or two RJ-45 port(s) for connection to DLM local network.
 - 3. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
 - 4. Device Status LEDs including:
 - a. PIR detection
 - b. Ultrasonic detection
 - c. Configuration mode
 - d. Load binding
 - 5. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
 - 6. Manual override of controlled loads.
- C. Units shall not have any dip switches or potentiometers for field settings.
- D. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.

2.5 DIGITAL WALL SWITCHES

- A. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration; available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening. Wall switches shall include the following features:
 - 1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
 - 2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
 - 3. Red configuration LED on each switch that blinks to indicate data transmission.

4. Load/Scene Status LED on each switch button with the following characteristics:
 - a. Bi-level LED
 - b. Dim locator level indicates power to switch
 - c. Bright status level indicates that load or scene is active
 5. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
- B. Two RJ-45 ports for connection to network.
- C. The following switch attributes may be changed or selected using a wireless configuration tool:
1. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
 2. Individual button function may be configured to Toggle, On only or Off only.
 3. Individual scenes may be locked to prevent unauthorized change.
 4. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
 5. Ramp rate may be adjusted for each dimmer switch.
 6. Switch buttons may be bound to any load on a room controller and are not load type dependent; each button may be bound to multiple loads.

2.6 ROOM CONTROLLERS

- A. Room Controllers automatically bind the room loads to the connected devices in the space without commissioning or the use of any tools. Room Controllers shall be provided to match the room lighting load and control requirements. The controllers will be simple to install and will not have, dip switches, potentiometers or require special configuration. The control units will include the following features:
1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
 2. Simple replacement – Using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf unit without requiring any configuration or setup.
 3. Device Status LEDs to indicate:
 - a. Data transmission
 - b. Device has power
 - c. Status for each load
 - d. Configuration status
 4. Quick installation features including:
 - a. Standard junction box mounting
 - b. Quick low voltage connections using standard RJ-45 patch cable

5. Non-Plenum rated
6. Manual override and LED indication for each load
7. Dual voltage (120/277 VAC, 60 Hz), or 347 VAC, 60 Hz (selected models only)
8. Zero cross circuitry for each load.

B. On/Off Room Controllers shall include:

1. One or two relay configuration
2. Efficient 150 mA switching power supply
3. Three RJ-45 local network ports

C. On/Off/Dimming enhanced Room Controllers shall include:

1. Real time current monitoring
2. Multiple relay configurations
 - a. One, two or three relays
 - b. One or two relays
3. Efficient 250 mA switching power supply
4. Four RJ-45 local network ports.
5. One dimming output per relay
 - a. Where indicated, one 0-10 volt analog output per relay for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting.
 - b. Where indicated, one forward phase control line voltage dimming output per relay for control of compatible two-wire or three-wire ballasts, LED drivers, MLV, forward phase compatible ELV, neon/cold cathode and incandescent loads.
6. The following dimming attributes may be changed or selected using a wireless configuration tool:
 - a. Establish preset level for each load from 0-100%
 - b. Set high and low trim for each load
 - c. Set lamp burn in time for each load up to 100 hours

2.7 CONFIGURATIONS TOOLS

- A. A configuration tool facilitates optional customization of DLM local networks, and is used to set up open loop daylighting sensors. A wireless configuration tool features infrared communications, while PC software connects to each local network via a USB interface.
- B. Features and functionality of the wireless configuration tool shall include:
1. Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet.
 2. High visibility LED display, pushbutton user interface and menu-driven operation.

3. Read, modify and send parameters for occupancy sensors, daylighting sensors, room controllers and buttons on digital wall switches.
4. Save up to nine occupancy sensor setting profiles, and apply profiles to selected sensors.
5. Temporarily adjust light level of any load(s) on the local network, and incorporate those levels in scene setting.
6. Adjust or fine-tune daylighting settings established during auto-commissioning, and input light level data to complete commissioning of open loop daylighting controls.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment level and plumb and according to manufacturer's written instructions.
- B. Mount lighting control devices according to manufacturer's written instructions and requirements in Division 26 Section "Common Work Results for Electrical."
- C. Mounting heights indicated are to bottom of unit for suspended devices and to center of unit for wall-mounting devices.

3.2 CONTROL WIRING INSTALLATION

- A. Install wiring between sensing and control devices according to manufacturer's written instructions and as specified in Division 26 Section "Low-Voltage Power Conductors and Cables" for low-voltage connections.
- B. Wiring Method: All wiring to be installed within walls shall be provided in raceway as specified in Division 26 Section "Raceways and Boxes for Electrical Systems." Wiring between devices above ceiling shall be open-air installed and supported every six feet. Non-supported cable or cable laid on ceiling is not permitted.
- C. Bundle, train, and support wiring in enclosures.
- D. Ground equipment.
- E. Connections: Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

3.3 SENSOR INSTALLATION

- A. All occupancy sensors, wall and ceiling units, shall be mounted in a backbox.
- B. Install and aim sensors in locations to achieve at least 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

C. Sensor Wiring Installation:

1. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
2. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
3. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.
4. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
5. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
6. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Common Work Results for Electrical."

3.5 FIELD QUALITY CONTROL

- A. Schedule visual and mechanical inspections and electrical tests with at least seven days' advance notice.
- B. Inspect control components for defects and physical damage, testing laboratory labeling, and nameplate compliance with the Contract Documents.
- C. Check tightness of electrical connections with torque wrench calibrated within previous six months. Use manufacturer's recommended torque values.
- D. Verify settings of photoelectric devices with photometer calibrated within previous six months.
- E. Electrical Tests: Use particular caution when testing devices containing solid-state components. Perform the following according to manufacturer's written instructions:
1. Continuity tests of circuits.
 2. Operational Tests: Set and operate devices to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
 - a. Include testing of devices under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.
- F. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

- G. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
- H. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

3.6 CLEANING

- A. Cleaning: Clean equipment and devices internally and externally using methods and materials recommended by manufacturers, and repair damaged finishes.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Client Agency's maintenance personnel as specified below:
 - 1. Train Client Agency's maintenance personnel on troubleshooting, servicing, adjusting, and preventive maintenance. Provide a minimum of two hours' training.
 - 2. Training Aid: Use the approved final version of maintenance manuals as a training aid.
 - 3. Schedule training with Client Agency, through Representative, with at least seven days' advance notice.

3.8 ON-SITE ASSISTANCE

- A. Occupancy Adjustments: Within two months of date of Substantial Completion, provide up to two Project site visits, to make program changes, and adjust controls to suit actual conditions.

END OF SECTION

SECTION 262416

PANELBOARDS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.
- B. Additional Related Sections Include:
 - 1. Division 26 Section "Commissioning of Electrical" for commissioning of systems and equipment.

1.2 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.
 - 3. Load centers.
 - 4. Electronic-grade panelboards.

1.3 DEFINITIONS

- A. ATS: Acceptance testing specification.
- B. GFCI: Ground-fault circuit interrupter.
- C. GFEP: Ground-fault equipment protection.
- D. HID: High-intensity discharge.
- E. MCCB: Molded-case circuit breaker.
- F. SPD: Surge protective device.
- G. VPR: Voltage protection rating.

1.4 SUBMITTALS

- A. Product Data: For each type of panelboard.
 - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
 - 2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details.
 - 2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
 - 3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
 - 4. Detail bus configuration, current, and voltage ratings.
 - 5. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 6. Include evidence of NRTL listing for series rating of installed devices.
 - 7. Include evidence of NRTL listing for SPD as installed in panelboard.
 - 8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 9. Include wiring diagrams for power, signal, and control wiring.
 - 10. Key interlock scheme drawing and sequence of operations.
 - 11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.
- C. Qualification Data: For testing agency.
- D. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- E. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NECA 407.

1.7 FIELD CONDITIONS

A. Environmental Limitations:

- 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding minus 22 deg F to plus 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

- 1. Ambient temperatures within limits specified.
- 2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Client Agency or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

- 1. Notify Professional no fewer than two days in advance of proposed interruption of electric service.
- 2. Do not proceed with interruption of electric service without Professional's written permission.
- 3. Comply with NFPA 70E.

1.8 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
 - 1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.
- F. Enclosures: Flush and Surface-mounted, dead-front cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Height: 84 inches maximum.
 - 3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
 - 4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
 - 5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 - 6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 - 7. Finishes:
 - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
 - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
- G. Incoming Mains:
 - 1. Location: Convertible between top and bottom.
 - 2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

H. Phase, Neutral, and Ground Buses:

1. Material: Tin-plated aluminum.
 - a. Plating shall run entire length of bus.
 - b. Bus shall be fully rated the entire length.
2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.

I. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Compression or Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
5. Ground Lugs and Bus-Configured Terminators: Compression or Mechanical type, with a lug on the bar for each pole in the panelboard.
6. Feed-Through Lugs: Compression or Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
7. Subfeed (Double) Lugs: Compression or Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
8. Gutter-Tap Lugs: Compression or Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.

J. NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

K. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

1. Percentage of Future Space Capacity: Five percent.

L. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.

2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 POWER PANELBOARDS

- A. Panelboards: NEMA PB 1, distribution type.
- B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 1. For doors more than 36 inches high, provide two latches, keyed alike.
- C. Mains: As indicated on drawings.
- D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in circuit breakers or Bolt-on circuit breakers.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers or Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- F. Branch Overcurrent Protective Devices: Fused switches.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- B. Mains: As indicated on drawings.
- C. Branch Overcurrent Protective Devices: Plug-in or Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- D. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- E. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 1. Thermal-Magnetic Circuit Breakers:
 - a. Inverse time-current element for low-level overloads.
 - b. Instantaneous magnetic trip element for short circuits.
 - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip Circuit Breakers:
 - a. RMS sensing.
 - b. Field-replaceable rating plug or electronic trip.
 - c. Digital display of settings, trip targets, and indicated metering displays.
 - d. Multi-button keypad to access programmable functions and monitored data.
 - e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
 - f. Integral test jack for connection to portable test set or laptop computer.
 - g. Field-Adjustable Settings:
 - 1) Instantaneous trip.
 - 2) Long- and short-time pickup levels.
 - 3) Long and short time adjustments.
 - 4) Ground-fault pickup level, time delay, and I squared T response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
6. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Subfeed Circuit Breakers: Vertically mounted.
9. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.
 - c. UL listed for reverse connection without restrictive line or load ratings.
 - d. Lugs: Compression or Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
 - f. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - g. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
 - h. Auxiliary Contacts: One, SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - i. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
 - j. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
 - k. Multipole units enclosed in a single housing with a single handle or factory assembled to operate as a single unit.
 - l. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.

- m. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.5 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Directory card inside panelboard door, mounted in transparent card holder or metal frame with transparent protective cover.
 - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.
- D. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
 - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.6 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NECA 407.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Comply with NECA 1.
- C. Install panelboards and accessories according to NECA 407.
- D. Equipment Mounting:
 - 1. Install panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Attach panelboard to the vertical finished or structural surface behind the panelboard.
 - 3. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- F. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- G. Mount panelboard cabinet plumb and rigid without distortion of box.
- H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- I. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.
- J. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
 - 2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- K. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- L. Install filler plates in unused spaces.
- M. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

- N. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- O. Mount spare fuse cabinet in accessible location.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Client Agency's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- D. Tests and Inspections:
 - 1. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.

c. Instruments and Equipment:

- 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

- E. Panelboards will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Professional of effect on phase color coding.
1. Measure loads during period of normal facility operations.
 2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Professional. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
 4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

3.6 PROTECTION

- A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

SECTION 262726
WIRING DEVICES

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.
- B. Additional Related Sections Include:
 - 1. Division 26 Section "Commissioning of Electrical" for commissioning of systems and equipment.

1.2 SUMMARY

- A. Section Includes:
 - 1. Straight-blade convenience.
 - 2. GFCI receptacles.
 - 3. Toggle switches.
 - 4. Wall switch sensor light switches with dual technology sensors.
 - 5. Wall switch sensor light switches with passive infrared sensors.
 - 6. Wall switch sensor light switches with ultrasonic sensors.
 - 7. Wall-box dimmers.
 - 8. Wall plates.

1.3 DEFINITIONS

- A. Abbreviations of Manufacturers' Names:
 - 1. Cooper: Cooper Wiring Devices; Division of Cooper Industries, Inc.
 - 2. Hubbell: Hubbell Incorporated: Wiring Devices-Kellems.
 - 3. Leviton: Leviton Mfg. Company, Inc.
 - 4. Pass & Seymour: Pass& Seymour/Legrand.
- B. BAS: Building automation system.
- C. EMI: Electromagnetic interference.
- D. GFCI: Ground-fault circuit interrupter.
- E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

- F. RFI: Radio-frequency interference.
- G. SPD: Surge protective device.
- H. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.
- D. Field quality-control reports.
- E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
 - 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 - 2. Devices shall comply with the requirements in this Section.
- D. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STRAIGHT-BLADE RECEPTACLES

- A. Duplex Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

2.3 GFCI RECEPTACLES

A. General Description:

1. 125 V, 20 A, straight blade, feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

2.4 TOGGLE SWITCHES

- ### A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

2.5 WALL SWITCH SENSOR LIGHT SWITCH, DUAL TECHNOLOGY

- ### A. Description: Switchbox-mounted, combination lighting-control sensor and conventional switch lighting-control unit using dual technology.

1. Connections: Provisions for connection to BAS.
2. Connections: Hard wired.
3. Connections: Wireless.
4. Rated 960 W at 120-V ac for tungsten lighting, 10 A at 120-V ac or 10 A at 277-V ac for fluorescent or LED lighting, and 1/4 hp at 120-V ac.
5. Integral relay for connection to BAS.
6. Adjustable time delay of 20 minutes.
7. Able to be locked to Manual-On mode.
8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc.
9. Comply with NEMA WD 1, UL 20, and FS W-S-896.

2.6 WALL SWITCH SENSOR LIGHT SWITCH, PASSIVE INFRARED

- ### A. Description: Switchbox-mounted, combination, lighting-control sensor and conventional switch lighting-control unit using passive infrared technology.

1. Connections: Provisions for connection to BAS.
2. Connections: Hard wired.
3. Connections: Wireless.
4. Rated 960 W at 120-V ac for tungsten lighting, 10 A at 120-V ac or 10 A at 277-V ac for fluorescent or LED lighting, and 1/4 hp at 120-V ac.
5. Integral relay for connection to BAS.
6. Adjustable time delay of 20 minutes.
7. Able to be locked to Manual-On mode.
8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc.
9. Comply with NEMA WD 1, UL 20, and FS W-S-896.

2.7 WALL SWITCH SENSOR LIGHT SWITCH, ULTRASONIC

- A. Description: Switchbox-mounted, combination, lighting-control sensor and conventional switch lighting-control unit using ultrasonic technology.
 - 1. Connections: Provisions for connection to BAS.
 - 2. Connections: Hard wired.
 - 3. Connections: Wireless.
 - 4. Rated 960 W at 120-V ac for tungsten lighting, 10 A at 120-V ac or 10 A at 277-V ac for fluorescent or LED lighting, and 1/4 hp at 120-V ac.
 - 5. Integral relay for connection to BAS.
 - 6. Adjustable time delay of 20 minutes.
 - 7. Able to be locked to Manual-On mode.
 - 8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc.
 - 9. Comply with NEMA WD 1, UL 20, and FS W-S-896.

2.8 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: Smooth, high-impact thermoplastic.
 - 3. Material for Unfinished Spaces: Smooth, high-impact thermoplastic.
 - 4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, thermoplastic with lockable cover.

2.9 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: Almond unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Connected to Emergency Power System: Red.
- B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Dimmers:
 - 1. Install dimmers within terms of their listing.
 - 2. Verify that dimmers used for fan-speed control are listed for that application.
 - 3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
- H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Test Instruments: Use instruments that comply with UL 1436.
- B. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- C. Tests for Convenience Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

- D. Wiring device will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION

SECTION 262816

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.
- B. Additional Related Sections Include:
 - 1. Division 26 Section "Commissioning of Electrical" for commissioning of systems and equipment.

1.2 SUMMARY

- A. Section Includes:
 - 1. Nonfusible switches.
 - 2. Molded-case circuit breakers (MCCBs).
 - 3. Molded-case switches.
 - 4. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.

5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.
- B. Shop Drawings: For enclosed switches and circuit breakers.
1. Include plans, elevations, sections, details, and attachments to other work.
 2. Include wiring diagrams for power, signal, and control wiring.
- C. Qualification Data: For qualified testing agency.
- D. Field quality-control reports.
- E. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 2. Altitude: Not exceeding 6600 feet.

1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with NFPA 70.

2.2 NONFUSIBLE SWITCHES

- A. Type GD, General Duty, Three Pole, Single Throw, 240-V ac, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- B. Type HD, Heavy Duty, Three Pole, Single Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Lugs: Mechanical or Compression type, suitable for number, size, and conductor material.
 - 4. Service-Rated Switches: Labeled for use as service equipment.

2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.
- B. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

- C. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker.
- D. MCCBs shall be equipped with a device for locking in the isolated position.
- E. Lugs shall be suitable for 140 deg F rated wire on 125-A circuit breakers and below.
- F. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.
- G. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- H. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- I. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 - 1. Instantaneous trip.
 - 2. Long- and short-time pickup levels.
 - 3. Long- and short-time time adjustments.
 - 4. Ground-fault pickup level, time delay, and I-squared t response.
- J. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- K. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- L. Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- M. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- N. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Mechanical or Compression type, suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 - 4. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

2.4 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1).
- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.
- D. Operating Mechanism: The circuit-breaker operating handle shall be externally operable with the operating mechanism being an integral part of the box, not the cover. The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.
- E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.
- F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 PREPARATION

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Client Agency or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Professional no fewer than seven days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.

3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

3.4 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in fusible devices.
- F. Comply with NFPA 70 and NECA 1.

3.5 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.

E. Tests and Inspections for Switches:

1. Visual and Mechanical Inspection:

- a. Inspect physical and mechanical condition.
- b. Inspect anchorage, alignment, grounding, and clearances.
- c. Verify that the unit is clean.
- d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
- e. Verify that fuse sizes and types match the Specifications and Drawings.
- f. Verify that each fuse has adequate mechanical support and contact integrity.
- g. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
- h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
- i. Verify correct phase barrier installation.
- j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
- d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.

- e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

F. Tests and Inspections for Molded Case Circuit Breakers:

1. Visual and Mechanical Inspection:

- a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
- b. Inspect physical and mechanical condition.
- c. Inspect anchorage, alignment, grounding, and clearances.
- d. Verify that the unit is clean.
- e. Operate the circuit breaker to ensure smooth operation.
- f. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
- g. Inspect operating mechanism, contacts, and chutes in unsealed units.
- h. Perform adjustments for final protective device settings in accordance with the coordination study.

2. Electrical Tests:

- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
- c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

- d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
 - e. Determine the following by primary current injection:
 - 1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.
 - f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.
 - g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
 - h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
 - i. Verify operation of charging mechanism. Investigate units that do not function as designed.
- 3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 4. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

- G. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- H. Prepare test and inspection reports.
 - 1. Test procedures used.
 - 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
 - 3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.7 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

END OF SECTION

SECTION 265119

LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 STIPULATIONS

- A. The specification sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.
- B. Additional Related Sections Include:
 - 1. Division 26 Section "Commissioning of Electrical" for commissioning of systems and equipment.

1.2 SUMMARY

- A. Section includes the following types of LED luminaires:
 - 1. Cylinder.
 - 2. Downlight.
 - 3. Linear industrial.
 - 4. Lowbay.
 - 5. Parking garage.
 - 6. Recessed linear.
 - 7. Strip light.
 - 8. Surface mount, linear.
 - 9. Surface mount, nonlinear.
 - 10. Suspended, linear.
 - 11. Suspended, nonlinear.
 - 12. Materials.
 - 13. Finishes.
 - 14. Luminaire support.
- B. Related Requirements:
 - 1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.

- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaires.
 - 4. Include emergency lighting units, including batteries and chargers.
 - 5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
 - 6. Photometric data and adjustment factors based on laboratory tests.
 - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
- B. Shop Drawings: For nonstandard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
- C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.
- D. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Luminaires.
 - 2. Suspended ceiling components.
 - 3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
 - 4. Structural members to which equipment and/or luminaires will be attached.
 - 5. Initial access modules for acoustical tile, including size and locations.

6. Items penetrating finished ceiling, including the following:

- a. Other luminaires.
- b. Air outlets and inlets.
- c. Speakers.
- d. Sprinklers.
- e. Access panels.
- f. Ceiling-mounted projectors.

7. Moldings.

- E. Qualification Data: For testing laboratory providing photometric data for luminaires.
- F. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- G. Product Certificates: For each type of luminaire.
- H. Product Test Reports: For each luminaire, for tests performed by a qualified testing agency.
- I. Sample warranty.
- J. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.5 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- C. Provide luminaires from a single manufacturer for each luminaire type.
- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- E. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.
 1. Obtain Professional's approval of luminaires in mockups before starting installations.
 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Professional 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.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.7 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE 7.

2.2 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Standards:
 1. ENERGY STAR certified.
 2. California Title 24 compliant.
 3. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
 4. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
 5. UL Listing: Listed for damp location.
 6. Recessed luminaires shall comply with NEMA LE 4.
 7. User Replaceable Lamps:
 - a. Bulb shape complying with ANSI C78.79.
 - b. Lamp base complying with ANSI C81.61.
- C. CRI of minimum 70. CCT of 3000 K.
- D. Rated lamp life of 50,000 hours to L70.
- E. Lamps dimmable from 100 percent to 0 percent of maximum light output.

- F. Internal driver.
- G. Nominal Operating Voltage: 120 V ac.
 - 1. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

2.3 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.
- B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- C. Diffusers and Globes:
 - 1. Prismatic acrylic.
 - 2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 3. Glass: Annealed crystal glass unless otherwise indicated.
 - 4. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
- D. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage, and coating.
 - c. CCT and CRI for all luminaires.

2.4 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.5 LUMINAIRE SUPPORT

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Professional, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.
- E. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
 - 1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 - 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 3. Adjust the aim of luminaires in the presence of the Professional.

END OF SECTION

SECTION 265219

EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Exit signs.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire" Paragraph.
- D. Lumen: Measured output of lamp and luminaire, or both.
- E. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.
 - 1. Include data on features, accessories, and finishes.
 - 2. Include physical description of the unit and dimensions.
 - 3. Battery and charger for light units.
 - 4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
 - 5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.
 - a. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

- b. **Manufacturers' Certified Data:** Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. **Shop Drawings:** For nonstandard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
- C. **Samples:** For each product and for each color and texture specified.
- D. **Samples for Initial Selection:** For each type of luminaire with factory-applied finishes.
- E. **Samples for Verification:** For each type of luminaire.
 - 1. Include Samples of luminaires and accessories to verify finish selection.
- F. **Product Schedule:**
 - 1. For emergency lighting units. Use same designations indicated on Drawings.
 - 2. For exit signs. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. **Qualification Data:** For testing laboratory providing photometric data for luminaires.
- B. **Product Certificates:** For each type of luminaire.
- C. **Sample Warranty:** For manufacturer's warranty.

1.6 CLOSEOUT SUBMITTALS

- A. **Operation and Maintenance Data:** For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 QUALITY ASSURANCE

- A. **Luminaire Photometric Data Testing Laboratory Qualifications:** Luminaire manufacturer's laboratory that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. **Luminaire Photometric Data Testing Laboratory Qualifications:** Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the National Volunteer Laboratory

Accreditation Program for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

- 1. Warranty Period: Two year(s) from date of Substantial Completion.

- B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

- 1. Warranty Period for Emergency Power Unit Batteries: Five years from date of Substantial Completion. Full warranty shall apply for the entire warranty period.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.
- C. Comply with NFPA 70 and NFPA 101.
- D. Comply with NEMA LE 4 for recessed luminaires.
- E. Comply with UL 1598 for fluorescent luminaires.
- F. Lamp Base: Comply with ANSI C81.61.
- G. Bulb Shape: Complying with ANSI C79.1.
- H. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body.

1. Emergency Connection: Operate one lamp(s) continuously at an output of 1100 lumens each upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
 2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Less than 0 deg F or exceeding 104 deg F, with an average value exceeding 95 deg F over a 24-hour period.
 - b. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
 - c. Humidity: More than 95 percent (condensing).
 - d. Altitude: Exceeding 3300 feet.
 4. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 5. Battery: Sealed, maintenance-free, nickel-cadmium type.
 6. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 7. Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
- I. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.
1. Emergency Connection: Operate one LED lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire.
 2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 3. Nightlight Connection: Operate lamp in a remote luminaire continuously.
 4. Battery: Sealed, maintenance-free, nickel-cadmium type.
 5. Charger: Fully automatic, solid-state, constant-current type.

6. Housing: NEMA 250, Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly shall be located no less than half the distance recommended by the emergency power unit manufacturer, whichever is less.
7. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
8. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
9. Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
10. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.2 EMERGENCY LIGHTING

- A. General Requirements for Emergency Lighting Units: Self-contained units.
- B. Emergency Lighting Unit:
 1. Emergency Lighting Unit: As indicated on drawings.

2.3 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 1. Operating at nominal voltage as indicated on drawings.
 2. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.

2.4 MATERIALS

- A. Metal Parts:
 1. Free of burrs and sharp corners and edges.
 2. Sheet metal components shall be steel unless otherwise indicated.
 3. Form and support to prevent warping and sagging.
- B. Doors, Frames, and Other Internal Access:
 1. Smooth operating, free of light leakage under operating conditions.
 2. Designed to permit relamping without use of tools.
 3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. Prismatic acrylic.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
4. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

D. Housings:

1. Extruded aluminum housing and heat sink.
2. Powder coat finish.

E. Conduit: Electrical metallic tubing, minimum 3/4 inch in diameter.

2.5 METAL FINISHES

- A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Support Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with NECA 1.

- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position when testing emergency power unit.
 - 3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.
- E. Wall-Mounted Luminaire Support:
 - 1. Attached to a minimum 20-gage backing plate attached to wall structural members.
 - 2. Do not attach luminaires directly to gypsum board.
- F. Suspended Luminaire Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 - 3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod and wire support for suspension for each unit length of luminaire chassis, including one at each end.
 - 4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- G. Ceiling Grid Mounted Luminaires:
 - 1. Secure to any required outlet box.
 - 2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
 - 3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Perform startup service:
 - 1. Charge emergency power units and batteries minimum of one hour and depress switch to conduct short-duration test.

3.6 ADJUSTING

- A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:
 - 1. Inspect all luminaires. Replace lamps, emergency power units, batteries, or luminaires that are defective.
 - a. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 2. Conduct short-duration tests on all emergency lighting.

END OF SECTION

SECTION 265619

LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:

- 1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
- 2. Luminaire supports.
- 3. Luminaire-mounted photoelectric relays.

B. Related Requirements:

- 1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color rendering index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of luminaire.
 - 1. Arrange in order of luminaire designation.

2. Include data on features, accessories, and finishes.
 3. Include physical description and dimensions of luminaire.
 4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
 5. Photometric data and adjustment factors based on laboratory tests.
 - a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
 - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
 6. Wiring diagrams for power, control, and signal wiring.
 7. Photoelectric relays.
 8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.
- B. Shop Drawings: For nonstandard or custom luminaires.
1. Include plans, elevations, sections, and mounting and attachment details.
 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Include diagrams for power, signal, and control wiring.
- C. Samples: For each luminaire and for each color and texture indicated with factory-applied finish.
- D. Product Schedule: For luminaires and lamps.
- E. Delegated-Design Submittal: For luminaire supports.
1. Include design calculations for luminaire supports.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Luminaires.
 2. Structural members to which equipment and luminaires will be attached.
 3. Underground utilities and structures.
 4. Existing underground utilities and structures.
 5. Above-grade utilities and structures.
 6. Existing above-grade utilities and structures.
 7. Building features.
 8. Vertical and horizontal information.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.

- C. Product Certificates: For each type of the following:
 - 1. Luminaire.
 - 2. Photoelectric relay.
- D. Product Test Reports: For each luminaire, for tests performed by a qualified testing agency.
- E. Source quality-control reports.
- F. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and photoelectric relays to include in operation and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
 - 2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

1.7 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.
- C. Provide luminaires from a single manufacturer for each luminaire type.
- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- E. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.9 FIELD CONDITIONS

- A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

- B. Mark locations of exterior luminaires for approval by Professional prior to the start of luminaire installation.

1.10 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including luminaire support components.
 - b. Faulty operation of luminaires and accessories.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Period: 2 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.2 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. UL Compliance: Comply with UL 1598 and listed for wet location.
- E. Lamp base complying with ANSI C81.61.
- F. Bulb shape complying with ANSI C79.1.
- G. CRI of minimum 70. CCT of 3000 K.
- H. L70 lamp life of 50,000 hours.
- I. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- J. Internal driver.

- K. Nominal Operating Voltage: 120 V ac.
- L. In-line Fusing: Separate in-line fuse for each luminaire.
- M. Lamp Rating: Lamp marked for outdoor use and in enclosed locations.
- N. Source Limitations: Obtain luminaires from single source from a single manufacturer.
- O. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.3 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

- A. Comply with UL 773 or UL 773A.
- B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.
 - 1. Relay with locking-type receptacle shall comply with ANSI C136.10.
 - 2. Adjustable window slide for adjusting on-off set points.

2.4 MATERIALS

- A. Metal Parts: Free of burrs and sharp corners and edges.
- B. Sheet Metal Components: Epoxy-coated steel. Form and support to prevent warping and sagging.
- C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.
- D. Diffusers and Globes:
 - 1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
 - 3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
- E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
 - 1. White Surfaces: 85 percent.

2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

G. Housings:

1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
2. Provide filter/breather for enclosed luminaires.

H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage and coating.
 - c. CCT and CRI for all luminaires.

2.5 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.
 - a. Color: Dark bronze.

- D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
 - 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As selected from manufacturer's standard catalog of colors.
 - b. Color: Match Professional's sample of manufacturer's standard color.
 - c. Color: As selected by Professional from manufacturer's full range.

2.6 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.
- C. Examine walls, roofs, and canopy ceilings and overhang ceilings for suitable conditions where luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Professional, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Comply with NECA 1.
- B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

- C. Install lamps in each luminaire.
- D. Fasten luminaire to structural support.
- E. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Support luminaires without causing deflection of finished surface.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- F. Wiring Method: Install cables in raceways. Conceal raceways and cables.
- G. Install luminaires level, plumb, and square with finished grade unless otherwise indicated.
- H. Coordinate layout and installation of luminaires with other construction.
- I. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.
- J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.4 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
- B. Perform the following tests and inspections:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 2. Verify operation of photoelectric controls.

C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):
 - a. IES LM-5.
 - b. IES LM-50.
 - c. IES LM-52.
 - d. IES LM-64.
 - e. IES LM-72.
2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

D. Luminaire will be considered defective if it does not pass tests and inspections.

E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.7 DEMONSTRATION

A. Train Client Agency's maintenance personnel to adjust, operate, and maintain luminaires.

3.8 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Professional.

END OF SECTION

SECTION 310513

RAIN GARDENS AND INFILTRATION AREAS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:
 - 1. Subgrade preparation
 - 2. Installation of rain garden and infiltration areas
 - 3. Soil amendments

1.3 RELATED SECTIONS

- A. Division 01, Section “Temporary Erosion and Sedimentation Control”
- B. Division 31, Section “Earth Moving”
- C. Division 32, Section “Planting Soils”
- D. Division 21, Section “Turf and Grasses”
- E. Division 33, Section “Storm Utility Piping and Structures”

1.4 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and methods needed for proper performance of the work of this Section, including all applicable City of Philadelphia codes and regulations.
- B. All materials, methods of construction and workmanship shall conform to applicable requirements of PennDOT Standard Specifications and AASHTO Standards, unless otherwise specified. The Standards for Soil Erosion and Sediment Control in Pennsylvania, as published by the PA Department of Environmental Protection shall be applicable where the work is not specifically detailed on the accompanying drawing or by local requirements.

1.5 SUBMITTALS

- A. Submit three copies of supplier’s documentation that Rain Garden soil meets requirements of Part 2.

1. Soils: Submit product data a minimum of 12 weeks before installation of planting soil.

1.6 PROJECT CONDITIONS

A. Protection of Existing Improvements

1. Do not damage or disturb existing improvements or vegetation. Provide suitable protection where required before starting work and maintain protection throughout the course of the work.
2. Restore damaged improvements, including existing paving on or adjacent to the site that has been damaged as a result of construction work, to their original condition or repair as directed to the satisfaction of the Client Agency, and authority having jurisdiction at no additional cost.

PART 2 - PRODUCTS

2.1 MINERAL AGGREGATES FOR RAIN GARDEN SOIL

A. General

1. Mineral Aggregate shall be free of wood, waste, coating, or any other deleterious material. All Mineral Aggregate passing the No. 200 sieve size shall be non-plastic.

B. Mineral Aggregate for Rain Garden Soil

1. Mineral Aggregate for rain garden soils shall be analyzed by an accredited lab using the sieve sizes noted below, and shall meet the following gradation:

Sieve Size	Percent Passing
1 inch	100
No. 4	60 - 100
No. 10	40 - 100
No. 40	15 - 50
No. 200	2 - 5

2. Efforts should be made to have the Mineral Aggregate for rain garden soils meet the following gradation coefficients: Coefficient of Uniformity ($C_u = D_{60}/D_{10}$) equal to or greater than 6; and Coefficient of Curve ($C_c = D_{30}^2/D_{60}D_{10}$) greater than or equal to 1 and less than or equal to 3.

2.2 RAIN GARDEN SOIL MIX

A. General

1. Rain Garden soil shall be a well-blended mixture of Mineral Aggregate and compost measured on a volume basis. It shall consist of two parts compost (approximately 35 to 40 percent) by volume meeting the requirements of Section 9-14.4(9) and three parts Mineral Aggregate (approximately 60 to 65 percent), by volume. The mixture shall be well blended to produce a homogeneous mix. Organic matter content shall be 4 to 9 percent, dry weight

basis, min compacted infiltration rate of 1 in/hr, with the final mix to be determined by the Professional based on samples and test results submitted.

2.3 COMPOSTED MATERIAL

- A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 7.0; moisture content 45 to 65 percent by weight; 100 percent passing through 3/8-inch sieve; soluble salt content of 1.5 decisiemens/m; not exceeding 1 percent inert contaminants and free of substances toxic to plantings; and bearing USCC's "Seal of Testing Assurance," and as follows:
1. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste such as Shredded and composed pine bark, composted pine needles, composed oak leaf. Composted municipal waste and biosolids alone is not acceptable unless it meets all of the criteria noted. Peat not permitted.
 2. Organic Matter Content: 25 – 55% of dry weight.
 3. Degree of Maturity: Dewer Self Heating VI-V, or Solivita Maturity Index 6-8, or CO2 Evolution 1.2% C/day.
 4. Ammonium: <200 ppm extract
 5. Carbon : Nitrogen Ratio: 10:1 to 25:1.
 6. Nutrient Content: Contains some nitrogen, phosphorus, potassium, calcium, magnesium, sodium and micronutrients including iron, copper, boron, and manganese. Nutrients shall be present in appropriate agricultural and horticultural proportions to prevent ion antagonism.
 7. Heavy metals: Concentrations of zinc, mercury, cadmium, lead, nickel, chromium, and copper must be below EPA and standards for biosolid applications to soils with human activity.
 8. Compost may be produced from several feedstocks or raw materials. In subparagraph below, revise types of feedstocks if limiting sources. Revise descriptions and insert product names if required.
 9. NOTE: Penn State's Agricultural Analytical Services Laboratory Compost Test 3A fulfills this requirement and meets strict EPA and US Compost Council standards.
- B. Compost not conforming to the above requirements or taken from a source other than those tested and accepted shall be immediately removed from the project and replaced at no cost to the Client Agency.
- C. The Contractor shall submit the following information to the Professional for approval:
1. The supplier shall verify in writing and provide lab analyses that the Materials comply with the processes, testing, and standards specified in these Specifications. An independent STA Program certified laboratory shall perform the analysis.
 2. A copy of the producer's STA certification as issued by the U.S. Composting Council.

Acceptance shall be based upon a satisfactory Test Report from an independent STA program certified laboratory and the sample(s) submitted to the Professional.

2.4 GEOTEXTILES

- A. Non-woven geotextile (drainage filter fabric) shall conform to the following:
1. Minimum flow rate of 110 gal/min/ft² ASTM D-4491
 2. Grab tensile strength min 150 lb ASTM D-4632
 3. Mullen Burst strength min 300 psi ASTM D-3786
 4. Puncture strength min 90 lb ASTM D-4833
 5. Apparent opening size 60-70 US Sieve ASTM D-4751
 6. Non-woven geotextile shall be Mirafi 160N, TerraTex NO6, Geotex 601, US Fabrics US 160NW, or equal as approved by the Professional.
- B. Waterproof Liner for Waterstop shall be 30 mil PVC or HDPE minimum.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine the areas and conditions under which work is to be performed and notify the Professional in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.

3.2 SUB-GRADE PREPARATION

- A. Existing sub-grade in Stormwater/Infiltration Areas shall **NOT** be compacted or subject to excessive construction equipment traffic unless otherwise indicated on the contract documents.
- B. Initial excavation can be performed during rough site grading but shall not be carried to within one foot of the final bottom elevation. Final excavation should not take place until all disturbed areas in the drainage area have been stabilized. If necessary, protect excavation from runoff and sediment deposition through erosion and sediment control practices such as compost filter sock installed around the upstream perimeter of infiltration area excavation.
- C. Where erosion has caused accumulation of fine materials and/or surface ponding in the graded bottom, this material shall be removed with light equipment and the underlying solids scarified to a minimum depth of 6-inches with a York rake or equivalent by light tractor.
- D. Bring sub-grade of rain garden area to line, grade, and elevations indicated. Fill and lightly re-grade any areas damaged by erosion, ponding, or traffic compaction. All rain garden areas shall be level grade on the bottom.
- E. Protect existing utilities within infiltration area. Meet all minimum cover requirements as shown on plans.

3.3 RAIN GARDEN/INFILTRATION AREA INSTALLATION

- A. Upon completion of sub-grade work, the Professional shall be notified and shall inspect at his/her discretion before proceeding with rain garden installation.

- B. Amended Rain Garden Soil shall be placed immediately after approval of sub-grade preparation/stone bed installation. Any accumulation of debris or sediment that takes place after approval of sub-grade shall be removed prior to installation of Rain Garden Soil at no extra cost to the Client Agency. Planting Soils shall be placed in accordance with Division 32, Section "Planting Soils".
- C. Begin placement of Rain Garden Soils by placing 6-inches of Rain Garden Soils on the excavated bed bottom and roto-tilling the Rain Garden Soils 4" to 6" into the existing subsoil.

Install remaining Rain Garden Soil in 6-inch maximum lifts and lightly compact (tamp with backhoe bucket or by hand). Do not allow equipment movement over Rain Garden Soil – **do not over compact**. Install Rain Garden Soil to grades indicated on the drawings, ensuring that Rain Garden Soils are brought to within 3" of final grade so that upon placement of mulch layer finish grade is met.
- D. Plant trees, shrubs, potted plants, and plugs according to design documents.
- E. Install 3" leaf compost mulch evenly as shown on planting plans. Do not apply mulch in areas where ground cover is to be grass or where cover will be established by seeding.
- F. Protect Stormwater/Infiltration Areas from sediment at all times during construction. Hay bales, diversion berms and/or other appropriate measures shall be used at the toe of slopes that are adjacent to Stormwater/Infiltration areas to prevent sediment from washing into these areas during site stabilization.
- G. When the site is fully vegetated and the soil mantle stabilized the Professional shall be notified and shall inspect the drainage area at his/her discretion before sediment control devices are removed.

END OF SECTION 310513

SECTION 311000

SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing above-grade site improvements.
3. Disconnecting, capping or sealing, and abandoning site utilities in place.
4. Disconnecting, capping or sealing, and removing site utilities.

B. Related Sections:

1. Division 1, Section "Temporary Erosion and Sediment Control".
2. Division 1, Section "Temporary Tree and Plant Protection"
3. Section 31, Section "Tree Protection and Trimming".
4. Division 31, Section "Earth Moving".
5. Division 33, Section "Storm Utility and Combined Sewer Drainage Piping and Structures".

1.3 MATERIALS OWNERSHIP

- A. All debris shall be hauled offsite.
- B. Topsoil shall be removed and stockpiled on site.
- C. Material to be retained/recycled by the Client Agency shall be removed and stored per the direction of the Client Agency.
- D. The Contractor shall remove from the site, recycle, or dispose of all building materials and wastes in accordance with the PaDEP Solid Waste Management regulations 25 PA Code 260, et seq. and 281.1 et seq.
- E. Except for materials indicated to remain Client Agency's property, cleared materials shall become Contractor's property and shall be removed from the site and disposed of in a legal manner.

1.4 QUALITY ASSURANCE

- A. Experienced Workers: Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts 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, including all applicable Kidder Township, and PA DEP codes and regulations.

1.5 PROJECT CONDITIONS

- A. Site Access: Minimize interference with adjoining walks and other adjacent occupied or used facilities during site-clearing operations. Maintain accessibility as required by drawings and requirements of the Client Agency.
 - 1. The contractor is required to maintain access to existing buildings and parking lots at all times.
 - 2. Provide alternate routes around closed or obstructed access ways and walks during each phase of construction.
- B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Client Agency's premises per Client Agency direction. Reuse item as indicated on Construction Documents.
- C. Notify PA One Call for area where Project is located before site clearing.
- D. Protection of persons and property:
 - 1. Barricade open depressions and holes occurring as part of this work and post warning lights on property adjacent to or with public access.
 - 2. If applicable, operate warning lights during hours from dawn to dusk each day and as otherwise required.
 - 3. Protect structures, utilities, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by operations under this Section.
 - 4. Certain present underground utilities may be indicated on the drawings in their approximate locations. The Contractor shall exercise extreme caution in excavation in the immediate vicinity of these utilities so that they may not be damaged, or their service interrupted. It is mandatory that these utilities be kept in continuous operation and the Contractor will be held responsible for any inconvenience or financial loss to the Client Agency resulting from carelessness or ineptness of the Contractor in executing this part of the work.
 - 5. Any sewers, pipes, conduits or systems in active use encountered during excavation are to be protected or diverted as directed by the Professional and left in satisfactory working condition.
 - 6. Sewers, pipes or conduits that have been abandoned may be cut off and securely capped or plugged at the limits of excavation.
 - 7. It shall be the duty of the Contractor to ascertain from the Client Agency or utility Client Agency where such services are in active use, or have been abandoned before proceeding as specified.
 - 8. The Contractor shall exercise due caution not to damage present manhole, inlet basins, or other items of underground construction which are to remain.
 - 9. Protect existing trees outside of construction limits. Refer to Division 1, Section "Temporary Tree and Plant Protection" and Construction Drawings.

- E. Pest Control: Contractor to engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using environmentally safe materials.

PART 2 - EXECUTION

2.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Provide erosion-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Locate and clearly flag trees and vegetation to remain or to be relocated.
- D. Protect existing site improvements to remain from damage during construction.
- E. Restore damaged improvements to their original conditions, as acceptable to the Client Agency.

2.2 TREE PROTECTION

- A. Refer to Division 1, "Tree Protection and Trimming" for requirements.

2.3 UTILITIES

- A. Locate, identify, disconnect and seal or cap off all utilities indicated to be removed.
 - 1. If required, arrange to shut off indicated utilities with utility companies or Client Agency.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Client Agency or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to the requirements indicated:
 - 1. Notify Client Agency not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Client Agency's written permission.

2.4 CLEARING AND GRUBBING

- A. Existing topsoil to be removed and stockpiled on site.
- B. Existing vegetation
 - 1. Do not remove trees, shrubs, and other vegetation indicated to remain.
 - 2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
 - 3. Use only hand methods.
- C. No burning is allowed.

2.5 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, walls, gutters, and aggregate base as indicated.
 - 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

2.6 DISPOSAL

- A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials, including trash and debris, and legally dispose of them off Client Agency's property, unless otherwise directed.
- B. Recycling: All locally recyclable materials should be separated and disposed of at local recycling facility.

END OF SECTION 311000

SECTION 312000
EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The work of this section includes all earthwork and related and incidental operations, including:

- 1. Site protection, erosion and sediment control, site clearing.
- 2. Preparing of subgrade for walkways and pavements.
- 3. Backfill and compaction required for the construction of driveway and trail surface aggregate.
- 4. Drainage fill course for support of building slabs is included as part of this work.
- 5. Excavating and backfilling of trenches within building lines.
- 6. Dewatering as required to keep excavations free of water and soil erosion during construction period.
- 7. Preparing subgrades for slabs on grade.
- 8. Excavating and backfilling for building structures.
- 9. Excavating and backfilling of utility trenches.
- 10. Excavating and backfilling for stormwater best management practices.

- B. Excavating and backfilling for underground mechanical and electrical utilities and buried mechanical and electrical appurtenances shall be by the mechanical or electrical contractor.

- C. Related Sections

- 1. Division 1, Section "Temporary Erosion and Sediment Controls".
- 2. Division 31, Section "Site Clearing".
- 3. Division 33, Section "Storm Utility Piping and Structures"
- 4. Division 33, Section "Water Utility Distribution Piping".
- 5. Division 33, Section "Sanitary Utility Sewerage Piping".

1.3 SUBMITTALS

- A. Test Reports: Submit the following reports in addition to other test reports described in subsequent sections directly to Professional from the testing services, with copy to contractor and Client Agency:
 - 1. Test reports on borrow material, including USCS classification (grain size, liquid limit, plastic limit, and natural water content), Clean Fill certification, and optimum moisture-maximum density curve for standard Proctor.
 - 2. Verification of suitability of each footing subgrade material, in accordance with specified requirements.

3. Field reports; in-place soil density tests.
 4. One USCS classification (grain size, liquid limit, plastic limit, and natural water content), Clean Fill certification, and optimum moisture-maximum density curve for standard Proctor for each fill and backfill material.
 5. Report of actual unconfined compressive strength and/or results of bearing tests of each strata tested.
- B. Submit supplier's documentation for driveway surface aggregate and trail surface aggregate material requirements of Sections 2.1.E.13 and 2.1.E.14.

1.4 QUALITY ASSURANCE AND CONTROL TESTING

- A. Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts 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 and follow Geotechnical recommendations. 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.
1. The Standards for Soil Erosion and Sediment Control In Pennsylvania, as published by the Pa. Department of Environmental Protection, shall be applicable where the work is not specifically detailed on the accompanying drawings or by local requirements.
 2. Earthwork recommendations outlined in the Project's current Geotechnical Engineering Report shall be followed unless otherwise noted.
- C. 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 weekly and after heavy rainfalls, and if damaged, repaired or replaced.
- D. A Geotechnical Testing Agency shall be retained by the Contractor to perform soil testing and inspection services for quality control during earthwork and site grading operations.
1. The Contractor shall submit data demonstrating the qualifications of the Geotechnical Testing Agency for approval by the Professional.
 2. The Geotechnical Testing Agency shall be qualified according to ASTM E 329 to conduct soil materials and rock definition testing as documented according to ASTM D 3740 and ASTM E 548.
 3. The Geotechnical testing agency shall have on staff a professional engineer who is legally authorized to practice in the jurisdiction where the Project is located and who is experienced in providing geotechnical engineering.
 4. The Geotechnical Testing Agency shall perform the tests and provide the services specified below and submit test reports to the Client Agency and Professional. All test reports must be signed and sealed by the qualified professional engineer responsible for their preparation.
 5. Testing shall be performed in the presence of a county/township representative.

- E. Field Engineering: A Surveyor shall be retained by the Contractor to provide field engineering services required for proper completion of the work including but not necessarily limited to layout work and setting of grades, slopes and levels:
1. The Contractor shall submit data demonstrating qualifications of persons proposed to be engaged for field engineering services for approval by the Professional.
 2. The surveyor shall submit documentation verifying that layout, grades, slopes and levels are in conformance with the drawings and specifications.
 3. The Contractor shall locate and protect control points and reference points throughout the progress of work.
- F. 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.
- G. 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.
- H. Quality Control tests shall include tests on fill material, optimum moisture content and maximum density and field density tests of fill layers. The Quality Control Agent shall comment on the suitability of all subgrades, and the subgrades shall be acceptable to the Consulting Geotechnical Engineer.
- I. 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.
- J. The Contractor shall request consultation with the Consulting Geotechnical Engineer on any problems that arise during construction. Copies of the daily in-place soil density tests shall be faxed to the consultant by the Contractor through the testing agency within twenty-four (24) hours of the time the tests are made.
- K. 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.
- L. 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.
- M. Compaction standards are to be based on the Modified Proctor standards, as defined by ATSM D1557.

1.5 REFERENCES

- A. Annual Book of ASTM Standards, 2005; American Society for Testing and Materials, Philadelphia, PA.
- B. Standard Specifications of the Pennsylvania Department of Transportation, latest edition, Pub. 408.
- C. Pennsylvania Department of General Services Project Procedure Manual, latest edition.

1.6 PROJECT CONDITIONS

A. Site Information

- 1. Existing data was used for the basis of the design and are available to the contractor for information only. Existing conditions are not intended as representations or warranties of accuracy or continuity. The Client Agency will not be responsible for interpretations or conclusions drawn from this data by Contractor.

B. Subsurface Information

- 1. Test borings and other exploratory operations may be performed by Contractor, at the Contractor's option; however, no change in the Contract Sum will be authorized for such additional exploration.
- 2. Any available data concerning subsurface materials or conditions based on soundings, test pits, or test borings, has been obtained by the Department for its own use in designing this Project. The Test Boring location drawings and the Test Boring Logs, as well as the Laboratory Test Results, contained within the Geotechnical Report are incorporated into the construction contract as a Contract Document. The remainder of the Geotechnical Report, with all other exhibits, is available for informational/guidance purposes only; it is not to be relied on by prospective Bidders. The Report is available to Bidders but the Bidders must agree and acknowledge that the information and recommendations in the Report are not warranted for accuracy; correctness or completeness, and is not incorporated into the construction contract as a Contract Document.
- 3. Test Boring logs reflect the conditions at the specific locations of each Test Boring only. The Contractor accepts full responsibility for any conclusions drawn with respect to conditions between Test Borings. Bidders may perform their own investigation of existing subsurface conditions, with the Department's approval. Excavation for the Project is "Unclassified", as fully described in the Excavation section.

C. Site Protection: Comply with requirements specified in Temporary Erosion and Sediment Controls, Section 015713, prior to the start of, and throughout, earthwork operations.

- 1. Before beginning site clearing or any other construction activity, Contractor shall set up and maintain temporary fencing along the limits of construction indicated on the drawing, staked out by the Contractor, and shall notify Professional.
- 2. This temporary fencing shall describe the area of protection of existing soils/vegetation to remain. Under no conditions shall this line be penetrated by any construction vehicle

or construction process, including storage of materials, waste, or fill, or for any purpose without the written consent of the Professional or Client Agency.

3. Temporary fencing shall be maintained in good condition throughout the work and shall be removed when work is completed.
4. Vegetation in protected areas which is damaged due to construction activities shall be replaced or otherwise restored to the satisfaction of the Professional and at no cost to the Client Agency.
5. Barricade open excavations occurring as part of this work and post with warning lights. Operate warning lights as recommended by authorities having jurisdiction.
6. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
7. Perform excavation by hand within dripline of large trees to remain. Protect root systems from damage or dryout to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with moistened burlap.
8. No vehicles shall be driven or parked under the canopy of trees nor shall material be stored or any construction activity take place under canopies except that directly related to work there.

D. Protection of Existing Utilities

1. Locate existing underground utilities in the area of the work prior to the beginning of the work. Where utilities are to remain in place, provide suitable protection where required before starting work and maintain protection throughout the course of the work. Do not interrupt existing utilities without written approval from the utility Client Agency.
 - a. Provide minimum of 48-hour notice to Professional, and receive written notice to proceed before interrupting any utility.
2. Should uncharted or incorrectly charted utilities be encountered during excavation, consult the utility Client Agency immediately for directions. Cooperate with the Client Agency and public and private utility companies in keeping their respective services and facilities in operation.
3. Restore damaged utilities to their original condition to the satisfaction of and at no cost to the Client Agency. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shutoff of services if lines are active.

- E. Use of Explosives: Use of explosives is not permitted without the prior approval of the Professional.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Satisfactory soil materials are defined as those complying with ASTM D2487 soil classification groups GW, GP, GM, SM, SW, and SP.
- B. Unsatisfactory soil materials are defined as those complying with ASTM D2487 soil classification groups GC, SC, ML, MH, CL, CH, 0L, OH, and PT.
- C. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel,

with 100 percent passing a 1-1/2 inch sieve and not more than 10 percent passing a No. 4 sieve and 0% passing No. 200 sieve.

D. Topsoil: Topsoil stripped and stockpiled on the site should be used for fine grading. Topsoil is defined as soil existing as top layer of earth on the site, which produces heavy growths of crops, grass or other vegetation. In the event that there is not sufficient stripped and stockpiled topsoil, furnish additional topsoil as needed conforming to the requirements specified in Division 32 Section, Planting Soils.

E. Fill and Backfill Materials:

1. Fill must have a bearing capacity of at least 3,000 pounds per square foot (PSF) when compacted to 95% of the maximum dry density (ASTM D-698 for trenches or other small spaces where large compaction equipment is not used)
2. Ordinary fill material shall be clean and free of high organic top soil, peat or muck, masonry materials, broken concrete or asphalt, stones larger than six inches, frozen lumps, trash, and other debris that would interfere with compaction or cause settlement. Fill material shall be of a moisture content suitable for compaction, and shall be obtained from a location that is normally dry and well-drained.
3. Fill material shall be of a moisture content suitable for compaction, specifically within +/- 2% of the optimum moisture content per the standard Proctor test (ASTM D698) and shall be obtained from a location that is normally dry and well-drained.
4. Select fill material shall be PENNDOT No. 2A per PENNDOT Section 703.2.
5. Should it be necessary to import fill material from off-site, the Contractor shall furnish certified report(s) of the testing laboratory showing the analysis of a representative sample of the material he proposes to use. A separate report shall be furnished for each source of material, including USCS classification (grain size, liquid limit, plastic limit, and natural water content), Clean Fill certification, and optimum moisture-maximum density curve for standard Proctor. The Contractor shall furnish the reports to the Professional for approval. Imported fill shall be well-graded granular material similar to PADOT 2A or crushed, recycled concrete with a gradation similar to PADOT 2A.
6. Structural Fill: Clean bank run sand and gravel containing non-plastic fines for that portion passing a No. 40 U.S. Standard sieve. Conform to the following gradation.

US Standard Sieve Size	Percent Passing
4 inch	100
No. 4	30 to 100
No. 200	0 to 12

- a. Material Availability: Borrow areas for structural fill material are not available on the site. Provide off-site materials of the quality specified and quantities required. Obtain material from a single source if possible.
7. Crushed Stone: Angular, washed natural stone; free of shale, clay, friable materials and debris; graded in accordance with ANSI/ASTM C136 within the following limits:

US Standard Sieve Size	Percent Passing
3/4 inch	95 to 100
5/8 inch	75 to 100
3/8 inch	55 to 85
No. 4	35 to 60
No. 16	15 to 35
No. 40	10 to 25
No. 200	5 to 10

8. Sand: Natural river or bank sand; dry, washed, free of silt, clay, loam, friable or soluble materials and organic matter; graded in accordance with ANSI/ASTM C136 within the following limits:

US Standard Sieve Size	Percent Finer By Weight
No. 4	100
No. 14	10 to 100
No. 50	5 to 90
No. 100	4 to 30
No. 200	0

9. Dense Graded Aggregate: Broken stone, crushed gravel or blast furnace slag conforming to the following gradation:

US Standard Sieve Size	Percent Finer By Weight
1 inch	100
3/4 inch	55 to 90
No. 4	25 to 60
No. 50	5 to 25
No. 200	3 to 12

10. Pea Gravel: Natural stone; washed, well rounded, clean, free flowing, free of clay, shale, organic matter; 1/4 inch minimum to 5/8 inch maximum size.
11. Porous Fill: Crushed stone aggregate conforming to the following gradation:

U.S. STANDARD SIEVE SIZE	PERCENT FINER BY WEIGHT
1 inch	100
3/4 inch	90
3/8 inch	30
No. 4	5
No. 8	0

12. Ballast: Coarse, crushed stone aggregate conforming to the gradation of Table C. and properties specified in PADOT 703.2
13. Driving Surface Aggregate (DSA)
- To be derived from natural stone formations.
 - Restricted to that which has been mined or quarried from existing geologic bedrock formations.

- c. 98% of fines passing the #200 sieve must be rock material. No clay or silt soil may be added.
 - d. Limestone material passing the #200 sieve may be used to make up a deficit in the distribution of sandstone aggregate rock and vice versa.
 - e. All added material passing the #200 sieve must be derived from rock material that conforms to program specifications.
 - f. The required sizes and allowed ranges, determined by weight, for various size particles shall be:
 - i. 1.5" sieve- 100% passing.
 - ii. 0.75" sieve- 65-95% passing.
 - iii. #4 sieve- 30-65% passing.
 - iv. #16 sieve- 15-30% passing.
 - v. #200 sieve- 10-15% passing.
 - g. The acceptable hardness as measured by weight loss is "less than 40% loss." Los Angeles abrasion test, AASHTO T-96 (ASTM C 131) shall be used to determine this property. Existing data from tests made for and approved by PennDOT will be accepted.
 - h. Aggregate must be in the range of pH 6 to pH 12.45 as measured by EPA 9045C.
 - i. Material is to be delivered and placed at optimum moisture content as determined for that particular source. The optimum percentage moisture is to be determined using Proctor Test ASTM D698, procedure C, Standard.
14. Trail Surface Aggregate (TSA)
- a. The subbase for the trail work shall be 6 inches of compacted PennDOT 2A aggregate over compacted subgrade.
 - b. The surface course for the trail work shall be 3 inches of the following TSA mix:
 - i. Combine aggregates and water in the ratio:
 - ii. 4 parts unwashed AASHTO #10.
 - iii. 4 parts AASHTO#8.
 - iv. 1 part minus #200 fines.
 - c. All components of the aggregate mix, including fines passing the #200 sieve are to be derived by crushing parent rock material that meets TSA purchasing specifications for abrasion resistance, pH and free from contaminants.
 - d. No clay or silt soil may be added or retained after processing operations.
 - e. Hardness:
 - i. The acceptable limits measured by weight loss are "less than 40% loss." Los Angeles Abrasion test, AASHTO T-96 (ASTM C 131) shall be used to determine this property. Existing data obtained from tests made for and approved by PennDOT will be accepted.
 - f. Optimum Moisture:
 - i. Material is to be delivered and placed at optimum moisture content as determined for that particular source. The optimum percentage moisture is to be identified by the supplier.

PART 3 - EXECUTION

3.1 TSA/DSA TRANSPORTATION

- A. Tarps are to be used to cover 100% of the load's exposed surface from the time of loading until immediately before dumping. This requirement includes standing time waiting to dump.

3.2 INSPECTION

- A. Examine the areas and conditions under which earthwork and site grading is to be performed and notify the Professional in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.

3.3 SITE PROTECTION MEASURES

- A. All temporary erosion and sediment control measures indicated on the drawings and as specified in Section 0015713 and all temporary fencing shall be in place before beginning any earthwork or sitework.
- B. Construction operations shall be carried out in a manner such that soil erosion and air and water pollution are minimized. State and local laws concerning pollution abatement shall be followed.
- C. The General Contractor shall be responsible for all soil erosion and sediment control and site protection during the construction period and shall provide barriers and other measures and devices to ensure that these specifications are complied with.
- D. Preventative measures against sinkhole formation:
 - 1. Provide positive drainage away from building areas and exposed rock at all times during construction.
 - 2. Avoid ponding water or concentrations of surface flows except where designated on the drawings.
 - 3. Prevent runoff water from flowing onto exposed subgrades. Close excavations as soon as possible after exposure. Foundation concrete should be placed the same day that excavation is completed.
 - 4. Backfill shall be compacted and be no more permeable than adjacent subgrade.
- E. Contractor shall notify the Professional before any work is begun on the site to review temporary erosion control measures, site protection, permanent stormwater management features, and the sequence of construction.
- F. Permanent stormwater management features and additional temporary erosion control measures as indicated on drawings shall be constructed after clearing and stripping of topsoil and are to be in place before the beginning of other construction activities.
- G. No water which transports sediment resulting from earth moving, demolition, or other construction activities shall be permitted to discharge beyond the limits of disturbance or grading indicated on the drawings.

3.4 SITE PREPARATION

- A. Following the setting up of temporary fencing, tree protection and temporary erosion control measures as specified, remove trees, shrubs, grass and other vegetation or obstructions which interfere with new construction. Completely remove stumps of trees and shrubs which are located within ten feet of proposed new construction, including buildings, roads, etc. to at least one foot below finish grade.
- B. Strip all topsoil to the full depth of the topsoil horizon, minimum 6 inches, from the area to be disturbed by new earthwork or construction.

1. Keep topsoil reasonably free from subsoil, debris, and stones larger than two inches.
2. Stockpile topsoil for future use in location to be approved by the Professional. If so directed by the Professional, create separate stockpiles for different stripped areas.
3. Prevent erosion of stockpiles, as specified in Section 015713.

3.5 EXCAVATION

A. BASIS OF CONTRACT

1. Excavation for this project shall be considered unclassified and shall include all types of earth and soil, and 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.
- B. The Contractor shall perform excavation to the dimensions and elevations indicated on the drawings for all buildings and structures and work incidental thereto. For excavation of stormwater BMPs, see Section 334100 – Storm Utility Piping and Structures.
- C. Excavated materials to be reused for topsoil, backfill, or other purposes shall be piled away from the edge of the excavated area a sufficient distance to prevent overloading the bank, and graded in such a way as to prevent surface water from entering the excavated area. Excess material from excavation not suitable or required for backfill or other purposes shall be hauled from the site as excavated and disposed of legally.
- D. Exposed subgrades outside of ultimate stormwater infiltration or bioretention areas shall be proof rolled with heavy pneumatic-tired equipment in the presence of the Geotechnical Testing Agency to identify soft pockets and areas of excess yielding. At minimum, a triaxle dump truck (loaded) with minimum tire pressure of 100 psi (Gross Vehicle Weight of 75,000 lb.) should be used. Do not proof roll wet or saturated subgrades. Do not operate the heavy duty roller within 10 ft of existing building walls. Instead, use a light duty walk-behind roller within that distance.
 1. Excavate and replace soft or unstable areas and replace with approved compacted fill as directed by the Geotechnical Testing Agency. Use select fill material specified in 2.1.E. as PADOT 2A per 703.2 or approved crushed, recycled concrete of similar gradation.
- E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Geotechnical Testing Agency.
- F. Excavation for Structures
 1. Excavation shall extend two (2) feet from the neat lines of structures to the face of bank

or shoring to allow working space and inspection, except where concrete is to be deposited directly against excavated surfaces.

2. Conform to elevations and dimensions shown within a tolerance of 0.10 feet.
3. All loose material shall be removed from excavations, and bottoms shall be carefully leveled to grade.
4. Do not excavate to full depth when rain or freezing conditions are imminent. Protect completed foundation soil surface from frost.
5. The Contractor shall furnish 48 hours advance notification to the Geotechnical Testing Agency of times when footing excavations are to be completed so that the bearing quality of bottoms may be inspected and/or tested. Place no forms or concrete before approval of the excavation by the Geotechnical Testing Agency.
6. The Geotechnical Testing Agency shall inspect the open excavation to verify the bearing capacity of supporting undisturbed soil. Natural and fill soils are to have a minimum bearing capacity of 3,000 psf (pounds per square foot).
7. If the Geotechnical Testing Agency determines that unsatisfactory soil is present, or that bearing capacity at the indicated elevation is inadequate, continue excavation and replace with approved compacted load-bearing structural fill material as directed by the Geotechnical Testing Agency. Such excavation shall be classified as additional work and payment shall be made in accordance with the General Conditions.
8. If foundation subgrade is found to be unstable or directly on rock, the existing soils/rock shall be removed to a minimum depth of two feet below the proposed bottom elevation, or to a depth where firm to stiff natural soils or rock is encountered. Replace undercut areas with approved compacted load-bearing structural fill material in accordance with these specifications and as directed by the Geotechnical Engineer.

G. Excavation for Trenches

1. Trenches shall be of minimum width necessary to lay pipes and shall be excavated to exact depth and grade. Trench bottoms shall have proper and uniform grade between inverts.
2. Bottoms of all trenches shall be trimmed by hand, so that the lower one-third of pipe is continuously supported on undisturbed or compacted soil with the slope of the pipe uniform between established elevations. Bottoms of all trenches shall be hand recesses at bells, pipe couplings, valves and other protuberances.
3. Where rock or shale is encountered, the trench shall be excavated deeper as indicated below, and a layer of rock-free gravel (1/4-inch maximum size) shall be hand tamped over the trench bottom. This bed shall be a minimum of 4 inches thick for pipes 8 inches and smaller, 6 inches for pipes 10 to 20 inches, and 9 inches for pipes 24 inches and larger. Additional similar material shall be packed around the pipe to a depth of approximately 1/2 of the diameter of the pipe.
4. Whenever wet or otherwise unstable soil that is incapable of properly supporting the pipe is encountered in the bottom of the trench, such soil shall be removed to the depth required and the trench backfilled to the proper grade with a coarse sand, fine gravel, or other approved material.

H. Excavation for Pavements

1. Cut surface under pavements to comply with cross-sections, elevations and grades as indicated.

I. Stability of Excavations

1. General: Comply with local codes, ordinances, and requirements of agencies having jurisdiction.
2. Slope sides of excavations to comply with local codes, ordinances, and requirements of agencies having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in safe condition until completion of backfilling.
3. Shoring and Bracing: Silty on-site soils are considered Type B per OSHA excavation regulations. The sidewalls of excavations deeper than 4 feet must be sloped, benched, or adequately shored per OSHA regulations. Provide materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross braces, in good serviceable condition. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Extend shoring and bracing as excavation progresses.
 - a. Provide permanent steel sheet piling or pressure-treated timber sheet piling wherever subsequent removal of sheet piling might permit lateral movement of soil under adjacent structures. Cut off tops a minimum of 2'-6" below final grade and leave permanently in place.

J. Dewatering

1. The contractor shall pump out or otherwise remove any water which may be found in the excavation, and he shall provide drainage ditches, under-drains, flumes, well points, and pumping equipment, as necessary, to keep the excavation entirely clear of water while the foundations are being built or other operations are being performed requiring a dry condition. Do not use trench excavations as temporary drainage ditches.
2. All discharge resulting from de-watering of excavations shall be collected and diverted to facilities for removal of sediment or into a sediment filter bag and discharged over a level vegetated area. Such facilities shall be reviewed and approved by the Professional before their construction. Water shall be conveyed to areas specified by the Professional on-site. No water shall be run directly to streams or drains.

K. Cold Weather Protection

1. Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.

3.6 FILLING AND BACKFILLING

A. General: Place soil material in layers to required subgrade elevations, for each area classification listed below, using materials specified in Part 2 of this Section.

1. Under grassed areas, use satisfactory excavated or borrow material.
2. Under walks, pavements, trails, and driveways, use subbase material, satisfactory excavated or borrow material or a combination.
3. Under steps, use subbase material.
4. Under footings and foundations use select fill material or approved imported load-bearing structural fill material.
5. Under building slabs, use drainage fill material.
6. Under piping and conduit and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation. Shape excavation bottom to fit bottom 90 degrees of cylinder.
7. Backfill trenches with concrete where trench excavations pass within 18 inches of

column or wall footings and that are carried below bottom of such footings or that pass under wall footings. Place concrete to level of bottom of adjacent footing.

- a. Concrete is specified in Division 3.
 - b. Do not backfill trenches until tests and inspections have been made and backfilling is authorized by Geotechnical Testing Agency. Use care in backfilling to avoid damage or displacement of pipe systems.
8. Provide 4-inch-thick concrete base slab support for piping or conduit less than 2'-6" below surface of roadways. After installation and testing of piping or conduit, provide minimum 4-inch-thick encasement (sides and top) of concrete prior to backfilling or placement of roadway subbase.

B. Approval of Bearing Strata

1. 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.
2. 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 classified 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 this omitted on the same basis.

C. Backfill excavations as promptly as progress of the Work permits, but not until completion of the following:

1. Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
2. Inspection, testing, approval, and recording locations of underground utilities have been performed and recorded.
3. Removal of concrete formwork.
4. Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Cut off temporary sheet piling driven below bottom of structures and remove in manner to prevent settlement of the structure or utilities, or leave in place if required.
5. Removal of trash and debris from excavation.
6. Permanent or temporary horizontal bracing is in place on horizontally supported walls.

D. Placing and compacting

1. Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.
2. When existing ground surface has a density less than that specified under "Compaction" for particular area classification, break up ground surface, pulverize, moisture-condition to optimum moisture content, and compact to required depth and percentage of maximum density.

3. Place backfill and fill 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.
4. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
5. Place backfill and fill materials evenly adjacent to structures, piping, or conduit to required elevations. Prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping, or conduit to approximately same elevation in each lift.
6. Control soil and fill compaction, providing minimum percentage of density specified for each area classification indicated below. Correct improperly compacted areas or lifts as directed by Geotechnical Testing Agency if soil density tests indicate inadequate compaction.
 - a. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density, in accordance with ASTM D698:
 - 1) Under structures, building slabs and steps, pavements, and utilities compact top 12 inches of subgrade and each layer of backfill or fill material at 98 percent maximum density.
 - 2) Under vegetated or unpaved areas, compact top 6 inches of subgrade and each layer of backfill or fill material at 85 percent maximum density.
 - 3) Under walkways, compact top 6 inches of subgrade and each layer of backfill or fill material at 95 percent maximum density.
 - 4) Under bioretention rain garden areas no compaction shall be permitted. Areas of the bioretention area compacted during the course of construction shall be harrowed or disced to restore permeability in accordance with bioretention area specifications. If permeability cannot be restored, over-excavation and backfill with clean, open-graded stone may be required.
 - 5) Under subsurface infiltration storage areas no compaction shall be permitted. Areas of the infiltration storage area compacted during the course of construction shall be harrowed or disced to restore permeability in accordance with storm utility piping specifications. If permeability cannot be restored, over-excavation and backfill with clean, open-graded stone may be required.
 - 6) Place DSA to a maximum un-compacted depth of 8" in one lift. Compact DSA to between 95% and 100% of the maximum dry mass density, determined according to PTM No. 106, Method B. At locations directed by the Department, determine the in-place density for each 3,000 square yards, of each layer according to AASHTO T 191 or T 310.
 - 7) When possible, a small paver should be used to place TSA. This will reduce aggregate segregation by size that occurs when any aggregate is dumped and spread. Minimum placement shall be 4" loose, 3" compacted. For TSA, a minimum 4 ton vibratory roller should be used to compact the final trail surface.
 - b. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material. Apply water in minimum quantity as necessary to prevent free water from appearing on surface during or subsequent to compaction operations.

- 1) Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
- 2) Stockpile or spread soil material that has been removed because it is too wet to permit compaction. Assist drying by discing, harrowing, or pulverizing until moisture content is reduced to a satisfactory value.
- 3) If aeration does not reduce the moisture content to an acceptable level, admixtures (lime, fly-ash, cement, or dry granular soil) will be required to modify moisture and aid in compaction. If admixtures are used, laboratory testing must be performed to determine the appropriate admixture(s) amounts, maximum dry density, and optimum moisture content.

3.7 FIELD QUALITY CONTROL

- A. Perform field density tests in accordance with ASTM D1556 (sand cone method) or ASTM D 2167 (rubber balloon method), as applicable.
 1. Field density tests may also be performed by the nuclear method in accordance with ASTM D6938, providing that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D1556.
 2. If field tests are performed using nuclear methods, make calibration checks of both density and moisture gages at beginning of work, on each different type of material encountered, and at intervals as directed by the Geotechnical Testing Agency.
- B. Footing Subgrade: For each strata of soil on which footings will be placed, perform at least one test to verify required design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested strata when acceptable to Professional.
- C. Paved Areas and Building Slab Subgrade: Perform at least one field density test of subgrade for every 2,000 sq. ft. of paved area or building slab, but in no case fewer than three tests. In each compacted fill layer, perform one field density test for every 2,000 sq. ft. of overlaying building slab or paved area, but in no case fewer than three tests.
- D. Foundation Wall Backfill: Perform at least one test for each 50 feet or less of wall length, but not fewer than two tests.
- E. Backfill at Retaining Wall: Perform at least one test for each 50 feet or less of wall length but not fewer than two tests.
- F. Trench Backfill: Perform at least one test for each 50 feet or less of trench length, but not fewer than two tests.
- G. If in opinion of Geotechnical Testing Agency, based on testing service reports and inspection, subgrade or fills that have been placed are below specified density, perform additional compaction, or remove and replace compacted fill material until specified compaction is achieved.

3.8 GRADING

- A. General: Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform

levels or slopes between points where elevations are indicated or between such points and existing grades.

- B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes and as follows:
 - 1. Lawn or Unpaved Areas: Finish areas to receive topsoil to within not more than 0.10 foot above or below required subgrade elevations.
 - 2. Walks: Shape surface of areas under walks to line, grade, and cross-section, with finish surface not more than 0.10 foot above or below required subgrade elevation.
 - 3. Pavements: Shape surface of areas under pavement to line, grade, and cross-section, with finish surface not more than 1/2 inch above or below required subgrade elevation.
- C. Grading Surface of Fill under Building Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/2 inch when tested with a 10-foot straightedge. The Surveyor shall verify that grades, slopes, and levels are in conformance with the drawings and specifications.
- D. Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum or relative density for each area classification.

3.9 CLAY LINER

- A. Foundation Preparation
 - 1. Foundation surfaces shall be graded to remove surface irregularities and shall be scarified or otherwise acceptably scored or loosened to a minimum depth of 2 inches. The moisture content of the loosened material shall be controlled as specified for the clay liner, and the surface materials of the foundation shall be compacted and bonded with the first layer of the clay liner as specified for subsequent layers of clay liner.
- B. Placement
 - 1. The clay liner shall not be placed until the required foundation preparation has been completed and the foundation has been inspected and approved by the Technician or Professional. The clay liner shall not be placed upon a frozen surface, nor shall snow, ice, or frozen material be incorporated in the clay liner.
 - 2. The clay liner shall be placed in lifts. The thickness of each lift before compaction shall not exceed the smaller of 6 inches or the length of the teeth of the footed compactor used.
 - 3. The distribution of materials throughout the clay liner shall be essentially uniform, and the clay liner shall be free from lenses, pockets, streaks, or layers of material differing substantially in texture, moisture content, or gradation from the surrounding material.
 - 4. If the surface of any layer becomes too hard and smooth for proper bond with the succeeding layer, it shall be scarified to a depth of not less than 2 inches before the next layer is placed.
- C. Control Of Moisture Content
 - 1. During placement and compaction of the clay liner, the moisture content of the clay being placed shall be maintained above optimum moisture as determined by the Standard

Proctor Test (ASTM D698) or Modified Proctor Test (ASTM D1557).

2. The application of water to the clay shall be accomplished at the borrow areas insofar as practicable. Water may be applied by sprinkling the clay after placement and before compaction of the liner, if necessary. Uniform moisture distribution shall be obtained by diskings

D. Compaction

1. The clay liner shall be compacted to a minimum of 95% of standard proctor dry density (ASTM D698) or to a minimum of 90% of modified proctor dry density (ASTM D1557), at a moisture content above optimum moisture.
2. The clay liner shall be compacted with a footed compactor weighing at least 25,000 pounds, operated continuously, in uncompacted lift thicknesses not to exceed the smaller of 6 inches or the length of the teeth on the footed compactor used.

E. Reworking Or Removal And Replacement Of Defective Liner

1. Clay placed at densities lower than the specified minimum density or at moisture contents lower than optimum moisture content or otherwise not conforming to the requirements of the specifications shall be reworked to meet the specifications or removed and replaced. The replacement clay and the foundation and fill surfaces upon which it is placed shall conform to all requirements of this specification for foundation preparation, approval, placement, moisture control, and compaction.

F. Testing And Documentation Requirements

1. Liner construction shall be tested and documented as specified below. Copies of the documentation report, including test locations and test results, shall be provided to the Client Agency.
2. Field and laboratory soil tests shall be completed on the clay liner, by a third party engineering or testing firm retained by the contractor, to document compliance with this specification. Testing shall be completed as the liner is being placed. The following tests shall be completed at the specified frequency.

Standard proctor test (ASTM D698)	1 per 5,000 cubic yards of clay liner
or	
Modified Proctor Test (ASTM D1557)	1 per 5,000 cubic yards of clay liner
Field density tests ASTM D6938, or or D2167, or D1556)	1 test per 100-foot grid per 1 foot thickness of clay liner
Atterberg Limit tests (ASTM D4318)	1 per 1,500 cubic yards of clay liner
Grain size distribution (ASTM D422)	1 per 1,500 cubic yards of clay liner
Permeability (ASTM D5084)	1 per 5,000 cubic yards of clay liner (2 minimum)

3. Atterberg limits, grain size distribution, and permeability tests shall be completed on undisturbed samples obtained from the constructed clay liner. A minimum of one of each of the laboratory tests specified above shall be completed per clay liner.
4. All test holes shall be backfilled using powdered bentonite mixed with clay soil used in liner construction and compacted by hand tamping. The clay shall be broken down into clods less than ½ inch in diameter. A minimum of 25% of the backfilled test hole volume

shall be occupied by powdered bentonite after backfilling

3.10 BUILDING SLAB DRAINAGE COURSE

- A. General: Drainage course consists of placement of drainage fill material, in layers of indicated thickness, over subgrade surface to support concrete building slabs.
- B. Placing: Place drainage fill material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting material during placement operations.
 - 1. When a compacted drainage course is indicated to be 6 inches thick or less, place material in a single layer. When indicated to be more than 6 inches thick, place material in equal layers, except no single layer more than 6 inches or less than 3 inches in thickness when compacted.

3.11 TEMPORARY SEEDING

- A. Temporary seeding and mulching shall be required on all freshly graded areas immediately following earthmoving procedures. Seeding shall be per Division 01, Section "Temporary Erosion and Sedimentation Controls". Straw bale barriers shall be placed in swale areas until vegetation is established.
- B. Should temporary seeding not be possible or not establish itself properly, mulch as described above, pending fine grading or permanent seeding.

3.12 FINISH GRADING

- A. Spreading of planting soil and finish grading shall be coordinated with the work of the Landscape Contractor and the seeding dates described in Division 32, Section "Exterior Plants". No work shall be performed until after verification of slopes and grades as described in this Section and until after approval by the Professional.
- B. Verify that the rough grades meet requirements for tolerances, materials, and compaction. Correct washouts, swales, berms, and other irregularities to provide a smooth, uniform surface without low places where water will stand.
- C. Surface of subgrades shall be loosened and made friable by cross-discing or harrowing to a depth of 2" (inches). Stones and debris more than 1-1.5" (inches) in any dimension shall be raked up and grade stakes and rubbish removed.
- D. Planting Soil shall be per Section 329100 and Section 329300. Planting soil shall be obtained from approved sources meeting the requirements of Section 329100 and Section 329300. Spread planting soil as specified in Section 329100 and Section 329300.
- E. Permanent seeding work shall be begun within one week of the completion of fine grading. If grading is completed at a time of the year when seeding work is not to be done or if this is otherwise not possible, mulch entire area with seed-free salt straw or salt hay at a rate of one ton per acre. Anchor mulch with a mulch binder approved by Professional.
- F. Any discrepancies which occur due to misgrading or to disturbance or erosion shall be regraded

and re-rolled to the satisfaction of the Professional.

3.13 DISPOSAL OF EXCESS AND WASTE MATERIALS

- A. Removal to Designated Areas on Client Agency's Property: Transport acceptable excess excavated material to designated soil storage areas on Client Agency's property. Stockpile soil or spread as directed by Professional.
- B. Removal from Client Agency's Property: Remove waste materials, including unacceptable excavated material, trash, and debris, and legally dispose of it off Client Agency's property. The Contractor is responsible for obtaining a legal disposal site and necessary permits (as required) for disposal of excess earthwork materials and debris. The Contractor also agrees to hold the Client Agency harmless from all damages, fines, etc. arising out of improper disposal, if not otherwise provided by law.

3.14 CERTIFICATION

- A. Upon completion of this portion of the work, and as a condition of its acceptance, deliver to the Professional written reports from the soils engineer and the surveyor.
 - 1. The Geotechnical Testing Agency shall certify that the compaction requirements have been obtained. State in the report the area of fill or embankment, the compaction density obtained, and the type or classification of fill material placed.
 - 2. The Surveyor shall certify that the layout, grades, slopes, and levels are in conformance with the drawings and specifications as outlined in this Section.

END OF SECTION 312000

SECTION 329100

PLANTING SOILS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Planting soils.
- 2. Installation.

- B. Related Sections:

- 1. Section 310513 "Rain Garden Soils"
- 2. Section 311000 "Site Clearing" for topsoil stripping and stockpiling.
- 3. Section 312000 "Earth Moving" for excavation, filling and backfilling, and rough grading.
- 4. Section 329100 "Turf and Grasses" for seeding.
- 5. Section 329300 "Plants" for planting and soil installation in planters.

1.3 DEFINITIONS

- A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- B. Finish Grade: Elevation of finished surface of planting soil.
- C. Planting Soil: Existing, native surface topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- D. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.
- E. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

1.4 ACTION SUBMITTALS

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

1. Soils: Submit product data a minimum of 12 weeks before installation of planting soil.
- B. Material Test Reports: For imported topsoil and manufactured planting soil for infiltration.
 1. Initial Planting Soil Sample: One test report for each planting soil type.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data:
 1. Landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of Client Agency's contact persons.
 2. Soil Mix Contractor: Include list of similar projects completed by Soil Mix Contractor demonstrating Contractor's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of landscape installers and Client Agency's contact persons.
- B. Product Certificates: For soil amendments and fertilizers, from manufacturer (submit product certificates a minimum of 12 weeks before planting soil mix installation).
 1. Manufacturer's certified analysis of standard products.
 2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful plant establishment.
 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 2. Experience: Five years' experience in turf and landscape installation in addition to requirements in Division 1 Section "Quality Requirements."
 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
- B. Soil Mixing Contractor Qualifications: A Soil Mixing Contractor capable of producing soil mixes meeting the specified tolerances and in quantities required for the Project. Contractor to engage Soil Mixing Contractor a minimum of six months before scheduled soil installation.
- C. Soil-Testing Laboratory Qualifications: An independent laboratory or university 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. Qualified independent soil-testing laboratories include, but are not limited to:
 1. Spectrum Analytic, Washington Court House, OH.

- D. Organic Matter Testing Laboratory Qualifications: An independent laboratory(ies) with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed. Qualified laboratories include, but are not limited to:
1. Organic Content Testing: Woods End Research Laboratory, Inc., Mt Vernon ME.
 2. Biological Testing: Soil Food Web Inc., Bohemia, NY.
- E. Soil Analysis: For infiltration planting soil mix, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the soil.
1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
 - a. Testing for Organic Matter in Planting Soil Mixes: Screen soil sample with a ¼-inch sieve.
 2. Comply with the soil-testing laboratory's written instructions for soil sampling.
 3. Report suitability of tested soil for intended use.
 - a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
 - b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.
- F. Organic Matter Biological Testing: For each organic matter type and from each source, furnish analysis and a written report from a qualified biological testing laboratory stating levels of following organisms: active bacteria, fungal compost, bacterial compost, active fungi, total fungal biomass, flagellates, amoebae, ciliates, and nematodes.
- G. Observations: Conduct the following site observations with the Professional. Notify Professional seven days in advance of review date.
1. Review of subgrade preparation.
 2. Review of planting soil installation.
 3. Review of finish grade.
- H. Preinstallation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.
- B. Handle soil materials only when the moisture content is less than field capacity. Do not handle, haul, place, or compact when soil is wet or frozen.
- C. Cover stockpiles of existing topsoil and planting soil mixes with filter cloth to protect from rain and groundwater wicking, or store in a covered space.

1.8 PROJECT CONDITIONS

- A. Construction Traffic: Close planting areas to construction traffic by other contractors when the work of this Section commences. Erect barricades as needed to prohibit unwanted traffic.
- B. Weather Limitations:
1. Proceed with preparation and installation of planting soil when existing and forecasted weather conditions permit.
 2. Begin soil tillage operations when soil moisture is around 10 percent by weight, or when tillage equipment does not leave large clods or smearing of soil faces. This is usually two days after good drying weather following a rain event, and before the soil becomes dry enough to raise dust.

PART 2 - PRODUCTS

2.1 INORGANIC SOIL AMENDMENTS

- A. Provide inorganic soil amendments as required by the Soil Analysis, provided by Professional.
- B. Sand: ASTM C 33, coarse, clean, washed, natural or manufactured silica sand or non-calcareous material, free of limestone, shale, and slate particles; and free of toxic materials.

2.2 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 6.0 to 8.0; moisture content 35 to 55 percent by weight; 100 percent passing through 3/4-inch (19-mm) 1/2-inch (12.5-mm) sieve; maximum soluble salt content of 1.5 decisiemens/m; minimum 200 ppm ammonium; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
1. Organic Matter Content: Minimum 40 percent of dry weight.

2. Carbon Nitrogen Ratio: 11:1 to 22:1.
3. Degree of Maturity: Thermal compost, minimum 6 to 8 weeks; heated to 140 degrees Fahrenheit for 7 consecutive days to kill weed seeds and pathogens.
4. Odor: Free of unpleasant residual odor such as hydrogen sulfide, ammonia, or others.
5. Heavy Metals: Not exceeding EPA and State's environmental protection agency standards for applications for human activity.
6. Feedstock: Compostable mixed waste (chipped, shredded and screened wood, leaves and bark), not including biosolids.
7. Biological Organisms: The following levels of organisms (direct microscopy):
 - a. Active Bacteria: Minimum 15 μg /g dw compost.
 - b. Total Bacteria Compost: 100 μg (fungal compost) to minimum 300 μg (bacterial compost) /g dw compost.
 - c. Total Active Fungi: Minimum 15 μg /g dw compost.
 - d. Total Fungal Biomass: Minimum 200 to maximum 400 μg /g dw compost.
 - e. Flagellates: Minimum 10,000.
 - f. Amoebae: Minimum 10,000.
 - g. Ciliates: Minimum 50 to maximum 100.
 - h. Total Nematodes: Minimum 20 to maximum 30, no root feeding nematodes.

2.3 PLANTING SOILS

- A. Landscape Planting Soil: Existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process and stockpiled on-site. Verify suitability of surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
 1. Supplement with sandy loam topsoil when quantities are insufficient. Mix with soil amendments as recommended in the Soil Report to produce planting soil with the following requirements:
 - a. Sand: 50 to 60 percent.
 - b. Silt: 20 to 30 percent.
 - c. Clay: 10 to 20 percent.
 - d. Organic Matter: Minimum 4 percent.
 - e. pH: 5.5 to 6.5.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive planting soil for compliance with requirements and other conditions affecting performance.
 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint

thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

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

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Professional and replace with new planting soil.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 EXCAVATION AND SCARIFICATION

A. Excavation of the soils shall be accomplished to a depths noted for each soil profile area. All construction debris shall be removed from the planting areas prior to placement of the soil layers. Care shall be taken to avoid working the soil when it has 10 percent moisture content or above.

B. Remediation / Rain Garden Subgrade Depth and Pitch: The subgrade shall be pitched toward the underdrainage with an average around 1 percent or about 1.25 inches fall per 10 feet.

1. Rain garden areas shall be excavated to elevations shown on the drawings.

C. Steep Slope Subgrade Depth and Pitch: For slopes over 3:1 gradient, the subgrade shall be terraced to fit the slope gradient with approximately 24-inch treads with 12- to 18-inch risers. The treads shall be slightly graded down slope to allow subsurface water to flow downhill and not collect at the tread/riser confluence.

3.4 SCARIFICATION OF THE SUBGRADE

A. After the specified engineering compaction for the subgrade is accomplished, scarification must loosen the compacted surface of the subgrade following final rough grade to a depth of 4 to 6 inches prior to the designed soil placement.

1. The subgrade shall have a permeability of not less than 0.2 inches/hour. Determine permeability of the subgrade using a single ring infiltrometer method after it has been scarified. If infiltration of the subgrade is below 0.2 in/hr. scarify perpendicular to previous scarification to a depth of 6 to 8 inches and retest for infiltration.
2. For slopes between 4:1 and 3:1, the subgrade shall be scarified parallel to the contour of the slope to a depth of 3 to 6 inches. The remaining ridges of loosened soil shall be 3 to 4 inches high.

3.5 PLANTING SOIL PREPARATION

A. Planting Soil:

1. Prepare preliminary planting soil mix and submit a 1-pint sample for Soil Analysis. When the Soil Analysis indicates compliance with requirements of specified planting soil, proceed with planting mix preparation. Set aside a 1-gallon sample of planting soil mix as standard of quality for later planting soil batches.
2. Add inorganic soil amendments at time of mixing. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
3. Protect the planting soil from erosion during preparation and before installation.

3.6 LANDSCAPE PLANTING SOIL INSTALLATION

A. Limit subgrade preparation to areas to be planted.

B. Clear subgrades of rocks, debris, and other contaminants to a depth of 6"

C. Subgrades Compacted by Construction Activity: Loosen subgrade to a depth of 18 inches with vertical trenches 24 inches apart. Loosen subsoil in two directions at right angles to each other. Recompact to less than 150 psi by field penetrometer measurement to depth of 9 inches.

D. 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 Professional's property. Loosen to less than 150 psi by field penetrometer measurement to depth of 6 inches.

1. If required by Soil Analysis, apply superphosphate fertilizer directly to subgrade before loosening.

a. Mix lime or sulfur, if required, with dry soil before mixing fertilizer.

E. Spread topsoil to a depth of 6 inches but not less than required to meet finish grades after compaction. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

1. Spread 3 inches of planting soil over loosened subgrade. Mix thoroughly into top 3 inches of subgrade. Spread remainder of planting soil.
2. Apply soil amendments and fertilizers as recommended in Soil Analysis on surface, and thoroughly blend to 4 inch depth.

3. Reduce elevation of planting soil to allow for soil thickness of sod.
- F. Spread existing, native surface topsoil and imported topsoil in separate areas. Do not intermingle.
- G. Stage installation of planting soil to avoid travel by equipment over placed planting soil.
- H. Planting Soil Depth Tolerances: Verify depth of planting soil horizons as they are installed.
 1. Tolerance: 3/8 inch, plus or minus.
- I. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Provide slopes indicated on Grading Plan. Grade to within plus or minus 1/2 inch (13 mm) 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.
- J. Compaction: Compact planting soil to 100 to 150 psi.
- K. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- L. Before planting, obtain Professional's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.7 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by installation of planting soil from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

END OF SECTION 329100

SECTION 329200
TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Seeding.
- 2. Hydroseeding.

- B. Related Requirements:

- 1. Section 329100 "Planting Soils" for planting soils and installation.

1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329100 "Planting Soils" and drawing designations for planting soils.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer.
- B. Product Data: For Seed and Mulch, from manufacturer

- C. Product Certificates: For fertilizers, from manufacturer.
- D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Client Agency for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.
 - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 - 2. Experience: Five years' experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."
 - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
 - a. Landscape Industry Certified Technician - Exterior.
 - b. Landscape Industry Certified Lawncare Manager.
 - c. Landscape Industry Certified Lawncare Technician.
 - 5. Pesticide Applicator: State licensed, commercial.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.
- B. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Accompany each delivery of bulk materials with appropriate certificates.

1.8 FIELD 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 15 to May 30.
 - 2. Fall Planting: September 1 to October 31.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.
- B. Grass-Seed Mix: Seed mix species as follows:
 - 1. For lawn areas: PennDOT Formula B-certified seed of grass species as follows, with not less than 98 percent pure seed, and not more than 0.15 percent weed seed:
 - a. 18% Perennial Ryegrass mixture (*Lolium perenne*). A combination of improved certified varieties with no one variety exceeding 50% of the total Ryegrass component and no less than 90% germination
 - b. 30% Creeping Red Fescue or Chewings Fescue with no less than 85% germination.
 - c. 52% Kentucky bluegrass mixture (*Poa pratensis*). A combination of improved certified varieties with no one variety exceeding 25% of the total Bluegrass component and no less than 80% germination.
 - d. For wooded areas: Basis of Design - Ernst Partial Shaded Area Roadside Mix (ERNMX-140)
 - 1) 49.7% *Schizachyrium scoparium*, Fort Indiantown Gap-PA Ecotype (Little Bluestem, Fort Indiantown Gap-PA Ecotype)
 - 2) 16.8% *Elymus virginicus*, PA Ecotype (Virginia Wildrye, PA Ecotype)
 - 3) 9.0% *Echinacea purpurea* (Purple Coneflower)
 - 4) 6.5% *Elymus hystrix*, PA Ecotype (Bottlebrush Grass, PA Ecotype)
 - 5) 3.5% *Chamaecrista fasciculata*, PA Ecotype (Partridge Pea, PA Ecotype)
 - 6) 3.0% *Rudbeckia hirta* (Blackeyed Susan)
 - 7) 2.0% *Heliopsis helianthoides*, PA Ecotype (Oxeye Sunflower, PA Ecotype)
 - 8) 1.3% *Zizia aurea*, PA Ecotype (Golden Alexanders, PA Ecotype)
 - 9) 1.2% *Pycnanthemum tenuifolium* (Narrowleaf Mountainmint)
 - 10) 1.0% *Penstemon digitalis*, PA Ecotype (Tall White Beardtongue, PA Ecotype)

- 11) 0.9% *Tradescantia ohiensis*, PA Ecotype (Ohio Spiderwort, PA Ecotype)
 - 12) 0.6% *Liatris spicata*, PA Ecotype (Marsh Blazing Star, PA Ecotype)
 - 13) 0.5% *Baptisia australis*, Southern WV Ecotype (Blue False Indigo, Southern WV Ecotype)
 - 14) 0.5% *Geum canadense*, PA Ecotype (White Avens, PA Ecotype)
 - 15) 0.4% *Asclepias tuberosa*, PA Ecotype (Butterfly Milkweed, PA Ecotype)
 - 16) 0.4% *Aster lateriflorus* (Calico Aster)
 - 17) 0.4% *Aster macrophyllus*, PA Ecotype (Bigleaf Aster, PA Ecotype)
 - 18) 0.4% *Monarda fistulosa*, Fort Indiantown Gap-PA Ecotype (Wild Bergamot, Fort Indiantown Gap-PA Ecotype)
 - 19) 0.3% *Asclepias syriaca*, PA Ecotype (Common Milkweed, PA Ecotype)
 - 20) 0.3% *Oenothera fruticosa* var. *fruticosa* (Sundrops)
 - 21) 0.2% *Aquilegia canadensis* (Eastern Columbine)
 - 22) 0.2% *Aster prenanthoides*, PA Ecotype (Zigzag Aster, PA Ecotype)
 - 23) 0.2% *Penstemon laevigatus*, PA Ecotype (Appalachian Beardtongue, PA Ecotype)
 - 24) 0.2% *Solidago bicolor*, PA Ecotype (White Goldenrod, PA Ecotype)
 - 25) 0.1% *Aster pilosus*, PA Ecotype (Heath Aster, PA Ecotype)
 - 26) 0.1% *Penstemon hirsutus* (Hairy Beardtongue)
 - 27) 0.1% *Solidago juncea*, PA Ecotype (Early Goldenrod, PA Ecotype)
 - 28) 0.1% *Solidago nemoralis*, PA Ecotype (Gray Goldenrod, PA Ecotype)
 - 29) 0.1% *Solidago odora*, PA Ecotype (Licorice Scented Goldenrod, PA Ecotype)
- e. For rain gardens: Basis of Design - Ernst Rain Garden Mix (ERNMX-180)
- 1) 34.5% *Schizachyrium scoparium*, Fort Indiantown Gap-PA Ecotype (Little Bluestem, Fort Indiantown Gap-PA Ecotype)
 - 2) 20.0% *Elymus virginicus*, Madison-NY Ecotype (Virginia Wildrye, Madison-NY Ecotype)
 - 3) 7.5% *Echinacea purpurea* (Purple Coneflower)
 - 4) 5.6% *Chasmanthium latifolium*, WV Ecotype (River Oats, WV Ecotype)
 - 5) 5.0% *Carex vulpinoidea*, PA Ecotype (Fox Sedge, PA Ecotype)
 - 6) 3.0% *Chamaecrista fasciculata*, PA Ecotype (Partridge Pea, PA Ecotype)
 - 7) 3.0% *Coreopsis lanceolata* (Lanceleaf Coreopsis)
 - 8) 3.0% *Panicum rigidulum*, PA Ecotype (Redtop Panicgrass, PA Ecotype)
 - 9) 3.0% *Rudbeckia hirta* (Blackeyed Susan)
 - 10) 2.0% *Heliopsis helianthoides*, PA Ecotype (Oxeye Sunflower, PA Ecotype)
 - 11) 2.0% *Panicum clandestinum*, Tioga (Deertongue, Tioga)
 - 12) 2.0% *Verbena hastata*, PA Ecotype (Blue Vervain, PA Ecotype)
 - 13) 1.7% *Asclepias incarnata*, PA Ecotype (Swamp Milkweed, PA Ecotype)
 - 14) 1.0% *Carex scoparia*, PA Ecotype (Blunt Broom Sedge, PA Ecotype)
 - 15) 1.0% *Senna hebecarpa*, VA & WV Ecotype (Wild Senna, VA & WV Ecotype)
 - 16) 0.9% *Penstemon digitalis*, PA Ecotype (Tall White Beardtongue, PA Ecotype)
 - 17) 0.8% *Zizia aurea*, PA Ecotype (Golden Alexanders, PA Ecotype)
 - 18) 0.7% *Pycnanthemum tenuifolium* (Narrowleaf Mountainmint)
 - 19) 0.5% *Baptisia australis*, Southern WV Ecotype (Blue False Indigo, Southern WV Ecotype)
 - 20) 0.4% *Aster lateriflorus* (Calico Aster)

- 21) 0.4% *Monarda fistulosa*, Fort Indiantown Gap-PA Ecotype (Wild Bergamot, Fort Indiantown Gap-PA Ecotype)
- 22) 0.3% *Aster novae-angliae*, PA Ecotype (New England Aster, PA Ecotype)
- 23) 0.3% *Aster prenanthoides*, PA Ecotype (Zigzag Aster, PA Ecotype)
- 24) 0.3% *Juncus tenuis*, PA Ecotype (Path Rush, PA Ecotype)
- 25) 0.2% *Eupatorium perfoliatum*, PA Ecotype (Boneset, PA Ecotype)
- 26) 0.2% *Helenium autumnale*, Northern VA Ecotype (Common Sneezeweed, Northern VA Ecotype)
- 27) 0.2% *Juncus effusus* (Soft Rush)
- 28) 0.2% *Oenothera fruticosa* var. *fruticosa* (Sundrops)
- 29) 0.2% *Solidago nemoralis*, PA Ecotype (Gray Goldenrod, PA Ecotype)
- 30) 0.1% *Solidago rugosa*, PA Ecotype (Wrinkleleaf Goldenrod, PA Ecotype)

2.2 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.
- D. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.3 PESTICIDES

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel,

- paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 3. Uniformly moisten excessively dry soil that is not workable or which is dusty.

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

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Professional and replace with new planting soil.

3.2 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
2. Protect grade stakes set by others until directed to remove them.

3.3 TURF AREA PREPARATION

A. General: Prepare planting area for soil placement and install planting soil according to Section 329100 "Planting Soils".

B. Moistened prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

C. Before planting, obtain Professional's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 HYDROSEEDING

A. Hydroseeding: Mix specified seed, Insert type, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with fiber-mulch manufacturer's recommended tackifier.
2. Spray-apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 lb/acre.

3.5 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll,

regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. 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 to a height of 2 to 2-1/2 inches.

D. Turf Postfertilization: Apply type of fertilizer at rate recommended in Soil Analysis after initial mowing and when grass is dry.

3.6 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Professional:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.

B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.7 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Client Agency's operations and others in proximity to the Work. Notify Client Agency before each application is performed.

- B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.8 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Client Agency's property.
- C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

3.9 MAINTENANCE SERVICE

- A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:
 - 1. Seeded Turf: 60 days from date of Substantial Completion.
 - a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

END OF SECTION 329200

SECTION 331100

WATER UTILITY DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The construction, installation, testing and disinfection of water service lines for potable water and fire protection supply lines.
- B. Connection to existing water lines, and reconnection of existing service laterals, hose bibs and yard hydrants and all appurtenances.
- C. NOTE: The Contractor will be responsible for all work included in these specifications and construction documents.

1.3 RELATED SECTIONS

- A. Division 31, Section "Earth Moving", including all excavation and backfill.
- B. Division 32, Section "Site Concrete".
- C. Division 33, Section "Sanitary Utility Sewerage Piping".

1.4 ACTION SUBMITTALS

- A. Submit manufacturer's technical data for each manufactured item listed.
- B. Submit a written procedure for cleaning water lines and disposing of fluidized materials removed.
- C. Submit methods and materials for any wet taps, where permitted by the Client Agency, for approval by the Professional. Submittals shall include documentation on the products to be used with complete instructions and procedures to ensure successful wet taps.

1.5 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and methods needed for proper performance of the work of this section.
- B. The installation of water mains, complete with fittings, valves, thrust blocks, harnessing, connections, and appurtenances, shall conform to AWWA Standard for Installation of Water Mains, C900, 2007 or later.

- C. Handle pipe carefully to ensure delivery at the project site in sound, undamaged condition. Contracting Officer will reject damaged pipe on site. Contractor shall replace damaged pipe at no additional expense to Client Agency.
- D. Do not store materials directly on the ground. Adequately support piping to prevent warpage. Use protective covers where piping may be damaged by direct sunlight.

1.6 CODES AND STANDARDS

- A. All work shall be in compliance with applicable requirements of Kidder Township Codes and PA State Regulations.
- B. International Mechanical Code. (IMC)
- C. NFPA 24
- D. International Plumbing Code

1.7 PROJECT CONDITIONS

- A. Protection of Existing Utilities
 - 1. Locate existing underground utilities in the area of the work prior to the beginning of the work. Where utilities are to remain in place, provide suitable protection where required before starting work and maintain protection throughout course of work. Do not interrupt existing utilities without written approval from Client Agency.
 - 2. The locations of all existing underground utilities are approximate and must be verified by the contractor prior to beginning any work.
- B. Demolition of Existing Utilities
 - 1. Whenever demolition of existing plumbing or piping systems occurs, no lines shall be left open ended. All lines to be demolished shall be terminated with either a valve and a cap or plug, or with just a cap or plug.
 - 2. All caps or plugs shall be installed to withstand the flow and pressure of the line that it is terminating in the event that the line is reenergized.
- C. Protection of Existing Improvements
 - 1. Provide suitable protection for existing improvements, paving, curbs, etc., where required before starting work and maintain protection throughout the course of the work.
 - 2. Restore damaged improvements to their original condition or repair as directed to the satisfaction of the Client Agency and at no cost to the Client Agency.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All materials must meet the requirements of Kidder Township Codes and Regulations.

- B. All plumbing materials shall be lead-free as defined in the Plumbing System Lead Ban and Notification Act, 35 P.S. & 723.1 et. seq.
- C. Connections
 - 1. For all service connections larger than two (2") inches, gate valves are required. Valves twelve (12") inches and less, shall be of the iron body, non-rising bronze stem, resilient seated wedge type equal to or exceeding the requirements of AWWA Specification C-515, with a working pressure of 250 psi. All valves shall open "LEFT" and shall be provided with a two (2") square wrench nut for buried service.
 - 2. End connections shall be mechanical joint, conforming to ANSI/AWWA C111 with all necessary accessories. Valves shall have a full opening flow way of equal diameter to the connecting pipe. Valve body, bonnet, stuffing box and disk castings shall be manufactured of ASTM A-126 Class B Gray Iron. All interior and exterior metal surfaces shall be fully coated with 4 mils, two-part epoxy coating.
- D. Plastic Piping
 - 1. All plastic pipe intended for use in the transport of potable water shall bear the label of an approved agency as conforming to NSF 14-90 "Plastic Piping Components and Related Materials".
 - 2. All plastic pipe and fittings shall conform to the requirements of Kidder Township.
 - 3. Lines four (4") inches or greater in diameter
 - a. DR18 PVC pipe conforming with AWWA C900-07, manufactured by North American Pipe Corporation or equal as approved by the Professional.
 - 4. All lines four (4") inches or greater in diameter must have Restrained Joints.
 - a. EBAA Iron Megalug 2000PV
 - b. Ford Meter Box Uni-Flange Series 1500 or 1500R
 - c. Romac RomaGrip
 - d. SIP Industries EZ Grip
 - e. Sigma Corp.s One-Lok SLCE or equal as approved by the Professional.
- B. Copper Piping
 - 1. Copper tubing shall be Seamless Type "K" copper, soft temper, for underground service, conforming to ASTM B-88 and B-251 for lines two (2") inches and less in diameter.
- C. HDPE IPS Pressure Pipe
 - 1. AWWA C901 SDR 9 Small Diameter Pressure-Rated HDPE Pipe meeting ANSI/AWWA C901, ASTM D3035, ASTM F714 (1/2" - 3" only)
- E. Bedding and backfill materials are defined in Section 312000, Earth Moving, and as indicated on the plans.
- F. Fittings
 - 1. All pipe fittings shall conform to the requirements of Kidder Township.
 - 2. Fittings shall be Ductile Iron compact mechanical joint fittings, in accordance with ANSI/AWWA C153/A21.53-88 standards, with mechanical joints conforming to ANSI/AWWA C111 complete with bolts, nuts.
 - 3. Fittings shall have a minimum rating of 350 psi
 - 4. All fittings shall be cement-lined, paint seal coated inside in accordance with

ANSI/AWWA C104/A21.4, and bituminous coated outside in accordance with ANSI/AWWA C153/A21.53. The Contractor shall submit to the Contracting Officer, in triplicate, a certification from the manufacturer that all fittings comply with the standards noted above.

5. All sleeves shall be of the Solid Sleeve Type with accessories and manufactured in the U.S.A.
6. Fittings four (4") thru sixteen (16) inches in diameter shall be manufactured by Tyler Union, US Pipe, McWane, or equal as approved by the Professional.
7. Mechanical joint restraints for PVC pipe shall be manufactured to ASTM A536, 60-42-10 ductile iron standards.
 - a. EBAA Iron Megalug 2000PV
 - b. Ford Meter Box Uni-Flange Series 1500 or 1500R
 - c. Romac RomaGrip
 - d. SIP Industries EZ Grip
 - e. Sigma Corp.s One-Lok SLCE or equal as approved by the Professional.
8. All nuts/bolts shall be installed with the proper torque according to the manufactures' instructions
9. Fittings for connection to PVC pipe shall be restrained.
10. Dielectric fittings are required at all copper/ferrous metal connections.
11. Stainless Steel Fabricated Tapping Sleeves: Tapping sleeves shall be split full circle band body, 18-8 Type 304 stainless steel; stainless steel flange, one hundred fifty (150) lb. drilling; Grade 60 full circumference gasket; Type 304 stainless steel nuts, bolts and washers, Teflon coated;
 - a. PowerSeal 3490 AS or
 - b. Mueller H304SS or
 - c. ROMAC SST III or equal as approved by the Professional.

G. Coatings

1. Cement-mortar lining shall conform to ANSI/AWWA C104/A21.5.

H. Valves

1. All valves shall open left.
2. Valves shall meet the requirements of the Kidder Township Codes and Regulations.
3. Gate valves shall be compliant with AWWA C509 and manufactured by:
 - a. Mueller Resilient Wedge
 - b. US Pipe Metro Seal Resilient Wedge
 - c. Clow Resilient Wedge
 - d. Kennedy Resilient Wedge
4. Gate valves shall be Resilient Wedge Gate Valves
 - a. Mechanical joint ends compliant with AWWA c111
 - b. Minimum working pressure – 200 psig
 - c. Valve shall feature an iron wedge fully encapsulated in molded rubber.
 - d. All valves shall open left.
 - e. Valves shall be epoxy coated
 - f. Epoxy coatings shall be compliant with AWWA C550

I. 7-inch Cast Iron Valve Box

1. Cast Iron Valve Box shall meet the requirements of Kidder Township Codes and

Regulations.

2. Cast Iron Valve Box shall be manufactured by
 - a. East Jordan Iron Works, catalog number 8550 or
 - b. Mueller Company Model A2360 or
 - c. Bingham and Taylor or equal as approved by the Professional
3. Riser shall feature screw type adjustment.
4. Components shall have an asphaltic coating
5. Lid shall contain the text "WATER"
6. Nominal diameter – 7-inches

J. Unions and Flanges

1. All unions and flanges on each side of all pieces of equipment and other similar items shall be designed in such a manner that they can be readily disconnected.
2. All unions and flanges must be placed in a location which will be readily accessible after completion of the project.

K. Concrete

1. Concrete used for thrust blocks, anchors, meter pit, manhole bases, cradle encasements, etc. shall conform to the applicable requirements of PennDOT Form 408, Section 704.1 for Class B Cement Concrete, and shall have a twenty-eight day minimum compressive strength of 3,000 psi.
2. Forms
 - a. Design of formwork and shoring shall be the responsibility of the contractor. Forms shall be securely built, to prevent movement or deflection during concreting, and tight to prevent leakage of mortar. They shall be sufficiently strong, braced and supported to resist the loads and pressures to which they are subjected during placing of concrete and shall remain in a straight, true alignment.
 - b. Forms shall not be removed until the concrete is able to withstand the stresses and strains that might be applied during the form stripping process.
3. Aggregates
 - a. All aggregates shall conform to the specifications outlined by ASTM C-33 and shall be free of all deleterious substances which cause reactivity with oxidized hydrogen sulfide.
4. Cement
 - a. Cement shall be Portland Cement and shall conform to ASTM C-150, Type 1.
5. Placing
 - a. All concrete shall be transferred from the mixer vehicle to the forms in a continuous fashion and without segregation or loss in ingredients until completion of each unit.
6. Curing
 - a. If steam curing, steam temperature shall not exceed 160 degrees and shall be increased from ambient temperature at a rate that does not exceed 40 degrees per hour.
 - b. Any curing compounds used must conform to ASTM C309.
7. Knockouts
 - a. All knockouts used to run pipes into and out of any structure shall be filled with 3000 PSI concrete tight to underside of upper section for full thickness of structure wall to insure transfer of all vertical loads.
8. Anchor Blocks

- a. All plugs, caps, tees and bends shall be provided with concrete anchor blocks, as specified.

L. Lawn Hydrants/Hose Bibs

1. All Lawn Hydrants shall be freezeless units, installed flush with grade, and have hinged cover locks with keys to prevent unauthorized use. Lawn Hydrants shall be
 - a. Woodford Model Y34 or
 - b. Murdock M-3909 or
 - c. Kupferle Corn King #903 or equal as approved by the Professional
2. All yard hydrants shall be installed with Double Check Backflow Preventer, valve, and valve box.

PART 3 - EXECUTION

3.1 WATER LINE INSTALLATION

A. Excavation and Backfill

1. See Section 31200, Earth Moving.

B. Pipeline Installation

1. General: the installation of water connections, complete with fittings, valves, thrust blocks, harnessing, connections, hydrants, and appurtenances, shall conform to AWWA standard for installation and all requirements of Kidder Township.
2. Handling of Materials: Pipe shall be handled so that the coating and lining is not damaged. If any part of the coating or lining is damaged, repairs shall be made by the Contractor at the Contractor's expense. Valves shall be stored and kept dry before installation. Lowering of water main material into trench shall conform to AWWA Specification C600 Section 7.
3. Cleaning Pipe and Fittings: All lumps, blisters, and excess coating shall be removed from the ends of each piece of pipe and fittings. The outside of the spigot, the inside of the bell, and the gasket shall be thoroughly wiped clean and dry before the pipe is installed.
4. Setting Valves and Valve Boxes: All valves shall be set vertical and be provided with a valve box. The tops of valve boxes shall be set neatly to existing grade.
5. Deflections from a straight line or grade measured between extended centerlines of the connected pipe shall not exceed more than 1-inch per linear foot.
6. All restoration by permittee is to be in accordance with PA DCNR and Kidder Township.

3.2 TESTING AND DISINFECTION

A. General

1. Testing and disinfection shall comply with AWWA C600 and AWWA C601 except as specified herein, and with all requirements of Kidder Township Codes and Regulations.
2. This section covers the testing and disinfection of water mains. The Contractor shall prepare a schedule and procedure for the testing and disinfection, and shall submit the same to the Client Agency for approval two weeks in advance of the time he intends to start the testing and disinfection, and shall give the Client Agency 24 hour notice prior to the performance of any test on the mains. The Client Agency reserves the right to modify

the testing and disinfection plan submitted by the Contractor based on the Client Agency's knowledge of the operational requirements of the water system.

B. Hydrostatic and Leakage Test

1. Where any section of water connection is protected by concrete reaction backings, the hydrostatic pressure test shall not be made until at least 7 days have elapsed after the concrete reaction backing was installed. If high early strength cement concrete is used for the reaction backing, the hydrostatic pressure test shall not be made until at least 3 days have elapsed.
2. The Contractor shall test each section between valves that have been incorporated into the pipeline to assure that those valves are pressure tight when in a closed position. The section of water main being tested shall be filled with water a minimum of 24 hours before the main is tested. During the filling of the pipe, extreme care must be exercised to ensure that all air is expelled from the pipeline. If necessary, the Contractor shall install taps on the main at the points of highest elevation. After completion of the test, the taps shall be tightly plugged unless otherwise noted. The taps necessary to release air or water from the main shall be made at the Contractor's expense, unless retained by the Client Agency for other use.
3. After the pipeline has been filled with water for 24 hours, a hydrostatic or pressure test shall be conducted by the Contractor. The duration of the pressure test shall be at least one hour. Each section of the water main shall be tested under a pressure of 150 psi, measured at the low point of the particular section being tested.
4. The section of pipe line being tested shall have the specified test pressure applied by means of a pump connected to the pipe in a manner satisfactory to the Client Agency. The pump, connection tap on the main, and all necessary apparatus, except the gage, shall be furnished and installed by the Contractor. The Contractor shall have backup equipment for testing to prevent delays if the original equipment breaks down. The Contractor shall furnish the test gage.
5. All exposed pipes, joints, fittings and valves will be carefully examined during the test, and all joints showing visible leakage shall be made tight. All defective pipe, fittings, and valves shall be removed from the line and replaced by the Contractor at no expense to the Client Agency.
6. Where the trench has been completely backfilled, whether at the option of the Contractor or required by the Client Agency, and the pressure gage fails to hold the required specified pressure, the Contractor shall open up the trench at his own expense and repair any leaks.
7. The leakage test shall have a minimum duration of 2 hours, and shall be at the same pressure as specified for the hydrostatic test. The leakage test shall be conducted in the same manner as the pressure test, except that the Contractor shall provide means for measuring the leakage, satisfactory to the Client Agency.
8. The leakage test may be conducted at the same time as the pressure test, provided suitable means are provided to measure the leakage during the pressure test, and a record of water added to the pipeline is kept for a period of at least two hours.
9. Should any test of a section of pipeline disclose leakage greater than that permitted, or any identifiable leakage, the Contractor shall, at his own expense, locate and repair the source of the leakage and shall retest the pipeline until the leakage is within the permitted allowance.

C. Preliminary flushing: Prior to disinfection, the sections of pipeline being disinfected shall be flushed as thoroughly as possible with the water pressure and outlets available. Flushing shall

be done after the pressure and leakage tests have been completed. If necessary, the line shall be opened up to flush as in a case where no hydrants are available.

- D. Chlorinating: Before being placed in service, all pipe installed under this contract shall be disinfected by chlorinating, utilizing either liquid chlorine or calcium hypochlorite.
1. Liquid Chlorine: A chlorine gas water mixture shall be applied by means of a solution feed chlorinating device in combination with a booster pump for injecting the chlorine gas water mixture into the main to be disinfected. This method shall be used only if the Contractor can demonstrate to the Client Agency that the person supervising the operation is thoroughly familiar with and experienced in the handling of chlorine gas and that the equipment to be used is suitable, and that proper safety equipment is available.
 2. Calcium Hypochlorite Solution: A chlorine water solution of 1 percent available chlorine shall be prepared, using granular calcium hypochlorite, and this solution shall be injected or pumped into the pipeline. A chlorine water solution of 1 percent available chlorine may be prepared by mixing approximately 1 pound of calcium hypochlorite with 8.5 gallons of water.
- E. Application of Chlorine: The hypochlorite solution shall be applied to the water main with a gasoline or electrically powered chemical feed pump, designed for feeding chlorine solutions. For smaller applications, the solution may be prepared in a barrel, and then pumped into the main with a hand pump, such as a hydraulic test pump. The dosage rate shall be such that the chlorine concentration in the water in the pipe is a minimum of 50 ppm available chlorine.
- F. Point of Application: The point of application of the chlorinating agent shall be at the low end of the pipeline section, and through a corporation stop inserted in the top of the new pipe.
- G. Rate of Application: The chlorine solution shall be pumped slowly into the new pipeline and application shall not cease until the entire main is filled with the chlorine solution. If required by the Client Agency, the chlorine residual shall be measured at several points along the section of main being tested.
- H. Prevention of Reverse Flow: Great care shall be exercised in manipulating valves, so that the strong chlorine solution in the line being treated will not backflow into the adjoining water distribution system.
- I. Retention Period and Chlorine Concentration: The chlorinated water shall be retained in the main for at least 24 hours, during which time all valves and hydrants in the section treated shall be operated, in order to disinfect the appurtenances. At the end of this 24 hour period, the treated water shall contain no less than 25 ppm chlorine throughout the length of the main. Should the initial procedure fail to result in the conditions specified, the chlorinating procedure shall be repeated until such results are obtained, at the Contractor's expense.
- J. Point of Discharge: The Contractor shall discharge the sterilizing solution from the mains through the outlets at the end of the main. The Contractor shall exercise all due precautions in discharging the chlorine bearing water, since it is extremely toxic, and if allowed to flow into streams, can readily destroy aquatic life. If any damage to property or fish life occurs due to the disposal of the sterilizing solution, the cost of damage shall be paid by the Contractor.
- K. Final Flushing: Following chlorinating, the heavily chlorinated water shall be thoroughly flushed from the line at its extremities until the replacement water throughout its length, upon

test, be proved comparable to the quality of water in the existing distribution system.

- L. Flushing Water: Water for flushing will be provided by the Client Agency, but at no time shall valves on the water distribution system operated without the presence of a duly qualified representative of the Client Agency.

3.3 PIPE IDENTIFICATION

- A. A plastic dig-warning tape shall be buried 24 inches above the top, but no shallower than 12 inches from the top of the final grade, for the pipe's full length. The tape shall be at least 6 inches wide. The tape shall have colored lettering or background color and worded to indicate the presence and the contents of the pipeline. Colors shall be as follows:
 - 1. Force main: brown
 - 2. Gravity sewer: green
 - 3. Water: blue
 - 4. Reclaimed water: purple
- B. Install 14-gauge UF (Underground Feeder per National Electric Code Article 339) solid tracer wire and joint seal along all non-metallic pipe. The wire shall be taped below the spring line of the pipe and shall be stubbed up at all valves and hydrants. At each valve the wire shall be installed along the outside of the valve box. Sections of wire shall be spliced together using a Buchanon tool or wirenut. Splicing by twisting the wire together is not acceptable. The wire shall have a plastic insulation, colored as follows:
 - 1. Force main: brown
 - 2. Gravity sewer: green
 - 3. Water: blue
 - 4. Reclaimed water: purple
- C. Each segment of tracer wire shall be demonstrated to be electrically continuous between turn-ups after backfilling and before the pipe is accepted as complete.

END OF SECTION 331100

SECTION 333100

SANITARY UTILITY SEWERAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Gravity-flow sanitary sewer, SDR 35 PVC gravity sewer pipe with watertight joints and cleanouts as per ASTM D 3034 for diameters 4'-15".
 - 2. All related earthwork, bedding, backfill, restoration and related tasks necessary for installation as shown on the construction drawings.
- B. Related Sections:
 - 1. Section 312000 - Earth Moving

1.3 ACTION SUBMITTALS

- A. Product Data: Provide catalog materials indicating pipe, pipe accessories, and fittings.
- B. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
- C. Manufacturer's Certificate: Certify that products meet or exceed ASTM designations
- D. Submit 3 copies of manufacturer's technical data for each manufactured item. Any alternative units must be approved by the Professional.

1.4 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and methods needed for performance of the work of this section.
- B. Codes and Standards: Perform work in compliance with the applicable requirements of governing authorities having jurisdiction.
- C. Where applicable, materials and workmanship shall conform to requirements of Pennsylvania Department of Transportation Specifications.
- D. All work shall be in compliance with applicable requirements of the Kidder Township.

E. REFERENCES

1. International Mechanical Code, latest edition.
2. Annual Book of ASTM Standards, 2005, or latest edition; American Society for Testing and Materials, Philadelphia PA.
3. Delaware Department of Transportation Standard Specifications Road and Bridge Construction, latest edition.
4. Pennsylvania Department of Transportation Specifications, latest edition, Publication 408.
5. Standards of the American Association of State Highway and Transportation Officials (AASHTO), 19th edition 1998 or latest edition.
6. International Plumbing Code, latest edition.
7. International Building Code, latest edition.

1.5 DEFINITIONS

- A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

PART 2 - PRODUCTS

2.1 SEWER PIPE MATERIALS

A. SDR-35 SANITARY SEWER

1. SDR 35 PVC gravity sewer pipe used in the construction of sewers, including bends, wye branches and other fittings, shall be manufactured and tested in accordance with the ASTM D 3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
2. All pipe, including bends, wye branches, and other fittings shall conform to Standard Details and Standard Specifications for Kidder Township.
3. All pipe shall be designed in accordance with Type 4 laying condition and a depth of cover that exceeds 20 feet per ANSI/AWWA C150/A21.50.
4. SDR-35 PVC gravity sewer pipe shall be push-on type, with bells, spigots and elastomeric gaskets, in accordance with, and in accordance with ASTM Standard D 3212, latest revisions.
5. Factory manufactured wye branches shall be used to connect drains to sanitary sewer conduit. Field fabricated wye branches and connections are not permitted.
6. All pipe shall be furnished with Push-on Type Joints, such as Ring-Tite. Joints shall be in accordance with ASTM D 3212, of latest revision, and be furnished complete with all necessary accessories including gaskets.
7. All pipe, fittings and accessories shall be installed and tested in accordance with the latest revision of ASTM D 2321.

PART 3 - EXECUTION

3.1 Preparation

- A. Hand trim excavations to required elevations. Correct over excavation with fine aggregate.
- B. Remove large stones or other hard matter which could damage pipe or impede consistent backfilling or compaction.

3.2 Bedding

- A. Type 4 bedding condition in sand, gravel, or crushed stone to depth of 1/8 pipe diameter, 4in minimum. Backfill compacted to top of pipe to approximately 80% Standard Proctor, per AASHTO T-99.
- B. Excavate pipe trench in accordance with Section 312000 for work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated.
- C. Maintain optimum moisture content of bedding material to attain required compaction density.

3.3 INSTALLATION - PIPE

- A. Install pipe, fittings, and accessories in accordance with ASTM D 2312 and/or manufacturer's instructions, complying with the New Castle County Specifications. Seal joints watertight.
- B. Lay pipe to slope gradients noted on civil engineering drawings; with maximum variation from true slope of 1/8 inch in 10 feet.
- C. Refer to Section 312000 for trenching requirements. Do not displace or damage pipe when compacting.
- D. For the security and safety of persons in and adjacent to trenches or construction operations, the "Manual of Accident Prevention in Construction" published by the Associated General Contractors of America shall be followed where specifically applicable, or where necessary for adequate protection.
- E. Pipe, fittings and accessories shall be loaded and unloaded by lifting with hoists or skidding so as to avoid shock or damage.
- F. Special care shall be taken to avoid damage to trees and their root systems. Machine excavation shall not be used when, in the opinion of the Client Agency, it would endanger the tree. All trees should be avoided outside the Client Agency's property line. All exposed roots must be clean cut.
- G. Where water is encountered, the contractor shall furnish and operate suitable pumping equipment of such capacity adequate to dewater the trench. The trench shall be sufficiently dewatered so that the laying and joining of the pipe is made in the dry. All trench water shall be conveyed to a swale or drainage channel without causing any property damage.
- H. Excavation and Backfill of Piping
 1. The word "rock" wherever used as the name of an excavated material, shall mean boulders and solid masonry larger than 1/2 cubic yard in volume, or solid ledge rock and masonry which, in the opinion of the Professional, requires for its removal, drilling and blasting, wedging, sledging, barring, or breaking up with a power operated hand tool. Any material which can be excavated using a hand pick and shovel, power operated excavator, power operated backhoe or shovel, shall not be defined as rock.
 2. No blasting of rock shall be permitted.
 3. Width of trenches shall be held to a minimum to accommodate the pipe and appurtenances. Trench walls shall be vertical, and bottoms shall be horizontal. The trench

width shall be not less than the outside diameter of the pipe barrel plus 8 inches, nor greater than the pipe diameter plus 24 inches. If this is exceeded, the contractor shall provide compacted stone bedding, at no cost to the Client Agency. The trench shall be excavated to the depth required. If, in the opinion of the Client Agency, subgrade conditions are not suitable, the Contractor shall excavate the unsuitable material and backfill to subgrade level with bedding material.

4. Bedding material consisting of AASHTO 2A aggregate shall be placed on the trench bottom, a minimum of 4 inches in depth, and thoroughly compacted with mechanical tampers. The bedding shall be graded by hand to provide a uniform and continuous bearing support for the pipe throughout its entire length.
5. After the pipe is laid, the bedding material shall be hand placed and carefully and thoroughly compacted under the haunches of the pipe and to a depth above the outside bottom of the pipe of 1/4 the pipe diameter, but in no case less than 2 inches, to insure proper support for the pipe over its entire length.
6. Between the bedding material and one foot over top of the pipe, the backfill material shall consist of clean, dry soil. The soil shall not contain stone larger than 2 (two) inches, shall be free from refuse, and shall have a minimum dry compacted weight of 90 lbs. per cubic foot. Frozen material shall not be used. Backfill material from one foot above the top of pipe to four inches below existing grade shall meet the above requirements except that stones no larger than 6 (six) inches will be allowed. The backfill material shall be thoroughly compacted by means of a mechanical tamper in 6 (six) inch lifts. When located in a landscape area, the remainder of the trench shall be refilled with stockpiled topsoil and seeded or planted as per the requirements of Division 32, Section "Plants". Where located in paved areas, the remainder of the trench shall be refilled with appropriate sub-base materials and paved as shown on applicable plans and specifications.
7. Sheeting, shoring and bracing shall conform to AWWA C600, Section 6.13. Sheeting shall be removed as the trench is backfilled, except where the Client Agency requires that it be left in place.

3.4 FIELD QUALITY CONTROL

- A. Compaction testing will be performed in accordance with ANSI/ASTM D698 or ASTM D6938.
- B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Client Agency.
- C. Deflection Test:
 1. Deflection tests shall be performed on all pipes. The test shall be conducted after the final backfill has been in place at least 30 days.
 2. No pipe shall exceed a deflection of 1.5% for pipes 15" - 36" in diameter. No deflection is allowed at the joint on sizes 12" and smaller.
 3. The deflection test is to be run using a Go / No-Go mandrel and shall have a diameter equal to 95% of the inside diameter of the pipe. The test shall be performed without mechanical pulling devices.

3.5 LEAKAGE TESTING

- A. Test all components in accordance with the Kidder Township Specifications as noted on plan.

- B. All sewers shall be subjected to either an infiltration or exfiltration test. The contractor shall furnish all labor, material and equipment necessary for testing. Exfiltration tests (air test) shall be conducted in lieu of infiltration tests when the pipe has been laid above the groundwater level. The tests shall be performed between two (2) manholes or as otherwise directed by the Professional for the Township and shall include all related sewerage facilities including the connections and cleanouts.
- C. If upon test failure, repairs are required, the Applicant shall be held responsible for the satisfactory, water tightness of the line and shall satisfactorily repair all leaks and make additional tests at the Applicant's expense.

- 1. Exfiltration Air Test

Prior to air testing, that section of pipe to be tested shall be flushed and cleaned of sand and other foreign matter. The test shall be made on a section of pipe from manhole to manhole.

The section of pipe to be tested shall be isolated with a plug installed at each end of pipe at the manholes. All laterals and cleanouts shall be plugged at ends and plugs should be braced securely. The plugs at each end of the pipe at the manholes must have provisions for connection of an air hose. One (1) plug shall be connected with an air hose to a portable air compressor with pressure regulators and gauges. The pressure regulators shall be used to control the rate at which air flows to the test section. The air pressure in the pipe shall be monitored by way of a pressure gauge connected to the plug at the opposite end of the sewer from the compressor. As air is supplied to the test section, it shall be monitored so that the pressure inside the pipe does not exceed 5.0 psig. When pressure reaches 4.0 psig, the air supply should be throttled so that internal pressure is maintained between 4.0 and 3.5 psig for at least two (2) minutes. This allows time for the temperature of the air to come to equilibrium with pipe walls.

After the temperature has been allowed to stabilize for two (2) minutes, the air supply shall be disconnected, and the pressure allowed to decrease to 3.5 psig. At 3.5 psig, the time required for pressure to drop to 2.5 psig shall be recorded. The time required for loss of 1.0 psig at an average pressure of 3.0 psig can be used to compute the rate of air loss. The minimum time allowable for pressure to drop 1.0 psig for 16" pipe is 7 minutes and 5 seconds.

- 2. Infiltration Test

The infiltration test shall be performed on those lines that are at or below the existing groundwater level. The rate of infiltration shall not exceed 50 gallons per mile per 24 hours per inch of diameter of sewer. Gushing or spurting streams entering the sewers shall be reason for test failure regardless of infiltration test results. The test shall not be conducted on sections of sewer in excess of 2,000 linear feet of street mains, trunks or interceptors.

- 3. Vacuum Testing Precast Concrete manholes.

- a. ASTM C1244, "Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill" shall be used to verify proper manhole installation prior to backfilling.

- D. Following all testing, the line shall be lamped and cleaned as required to ensure proper operation.
- E. Following cleaning, the sewer line shall be video inspected and a copy of the video to be provided to the Client Agency.

3.6 JOB CONDITIONS

- A. Protection of Existing Utilities - Locate existing underground utilities in the area of the work prior to the beginning of the work. Where utilities are to remain in place, provide suitable protection where required before starting work and maintain protection throughout course of work. Do not interrupt existing utilities without written approval from utility Client Agency. Report any discrepancies that might affect work to the Client Agency immediately.
- B. Protection of Existing Improvements - Provide suitable protection for existing improvements, paving, curbs, etc., where required before starting work and maintain protection throughout the course of the work.
- C. Restore damaged improvements to their original condition or repair as directed to the satisfaction of the Client Agency and Borough and at no cost to the Client Agency.
- D. Safety and Traffic Control
 - 1. Notify and cooperate with Kidder Township and other organizations having jurisdiction (such as PA DCNR, PennDOT and local agencies) when construction work will interfere with existing roads and traffic.
 - 2. Provide temporary barriers, signs, warning lights, flagmen, and other protections as required to assure the safety of persons and vehicles around the construction area and to organize the smooth flow of traffic.

3.7 PIPE IDENTIFICATION

- A. A plastic, detectable, dig-warning tape shall be buried 24 inches above the top, but no shallower than 12 inches from the top of the final grade, for the pipe's full length. The tape shall be at least 6 inches wide. The tape shall have colored lettering or background color and worded to indicate the presence and the contents of the pipeline. Terra Tape Sentry Line Detectable Pro-Line Safety, Presco, or Detectable Marking Tape by T. Christy Enterprises or equal as approved by the Professional. Colors shall be as follows:
 - 1. Force main: brown
 - 2. Gravity sewer: green
 - 3. Water: blue
 - 4. Reclaimed water: purple

END OF SECTION 333100

SECTION 33410

STORM UTILITY PIPING AND STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. The construction of inlets, trench drains, stormwater piping, outlet control structures and other structures as shown on plan.
 - 2. Any incidental or related operations.

1.3 RELATED SECTIONS:

- A. Division 31, Section "Earth Moving".
- B. Division 31, Section "Site Concrete".
- C. Division 33, Section "Rain Garden and Infiltration Areas"

1.4 ACTION SUBMITTALS

- A. Submit three copies of catalogue cuts of all fabricated materials including pipes, inlet boxes, grates, trench drains, outlet control structures such as domed risers, level spreaders, etc. for approval by the Client Agency prior to ordering.
- B. Submit sieve analysis for all sub-base material.
- C. Submit shop drawings of all fabricated materials as specified to Client Agency for approval prior to ordering.
- D. Submit calculations for Pre-cast inlets and domed risers signed and sealed by a PA licensed Professional.

1.5 QUALITY ASSURANCE

- A. Experienced Works: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts 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, including all applicable local and PA

DEP codes and regulations.

- C. Materials and workmanship shall conform to applicable requirements of Pennsylvania Department of Transportation Specifications.
- D. All work shall be in compliance with applicable requirements of codes and regulations.
- E. References
 - 1. Annual Book of ASTM Standards, latest edition; American Society for Testing and Materials, Philadelphia PA.
 - 2. Pennsylvania Department of Transportation Specifications, latest edition, Publication 408.
 - 3. Standards of the American Association of State Highway and Transportation Officials (AASHTO), latest edition.
 - 4. Kidder Township codes and regulations.

1.6 PROJECT CONDITIONS

- A. Conform to all conditions and restrictions included in other sections, including erosion and sediment control, protection of vegetation, existing improvements and utilities.
 - 1. All work shall be in accordance with the laws of the Commonwealth of Pennsylvania and Kidder Township codes and regulations.
 - 2. The Contractor shall apply and pay for all necessary permits and fees required in the course of his work as required by the governing codes.
 - 3. The Contractor shall be responsible for coordinating his work with the work of other trades. Do no work that will damage, displace, or make unnecessarily difficult the installation of the work of other trades.
 - 4. Notify and cooperate with local authorities and other organizations having jurisdiction (such as PennDOT) when construction work will interfere with existing roads and traffic. The Contractor is responsible for obtaining all required permits for construction activity.
 - 5. Provide temporary barriers, signs, warning lights, flagmen, and other protections as required to assure the safety of persons and vehicles around the construction area and to organize the smooth flow of traffic in compliance with local regulations and permit requirements.
 - 6. The Contractor shall not cover any work until it has been inspected by the Professional. Any work covered prior to inspection shall be opened to view by the Contractor at his expense.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Pipe
 - 1. All pipe, including bends, wye branches, and other fittings shall conform to the Kidder Township codes and regulations.
 - 2. High Density Polyethylene Pipe (HDPE) shall conform to AASHTO M 252., ASTM F-405 and ASTM F-667 for materials and fabrication, shall be dual walled, smooth lined, water tight, and shall be as manufactured by ADS, Hancor, Lane, or JM Eagle or equal as

- approved by the Professional.
3. Reinforced concrete pipe shall conform to ASTM C-76, Class III, Wall B or AASHTO T33. Reinforced concrete pipe shall meet the requirements of Kidder Township codes and regulations for materials and fabrication. Quadrant reinforcing of pipe is not permitted.
 4. All reinforced concrete pipe shall have rubber gasket joints conforming to ASTM C 443 Standard Specifications for Joints for Circular Concrete Sewer and Culvert Pipe Using Rubber Gaskets.
 5. Factory manufactured wye branches shall be used to connect drains to stormwater conduit. Field fabricated wye branches and connections are not permitted. Ductile iron pipe used in the construction of sewers, including bends, wye branches and other fittings, shall be manufactured and tested in accordance with the American National Standard for Ductile Iron Pipe, AWWA C151.
 6. Unless otherwise noted, the pipe shall be Class 56 for pipe 12 inches diameter and smaller and Class 54 for pipe larger than 12 inches in diameter.
 7. All ductile iron pipes and fittings used in the construction of sewers including bends and wye branches shall have gasket joints conforming with AWWA C111. Pipe and fittings shall have push on joints.
 8. PVC Pipe: Poly (Vinyl Chloride) Pipe, SDR -35, shall be ANSI/ASTM D 3033, Type PSP or ASTM D 3034, Type PSM.

B. Structures

1. Storm Drain Inlets, Manholes, Trench Drains and Structures:
 - a. Concrete Construction: Concrete construction shall be in accordance with Section 1001, PennDOT Specifications, latest edition.
 - b. Concrete Trench drains, Inlets and Manholes: Precast concrete inlets/manholes may be substituted for cast-in-place structures and shall be constructed as specified for cast-in-place. Precast structures may be used in only those areas where there is no conflict with existing underground structures which may necessitate revision of inverts. Concrete structures shall be placed on a 6 or 8 inch bed of compacted coarse aggregate Size No. 2A or as indicated on Plans and Details. Reinforcement steel, if required for handling, shall have a minimum of 2 inch cover. Handling devices, if used, shall be removable and the holes filled with concrete. Precast inlet structures will be modified to provide 12"-18" sediment storage and bottom leaching basins, open to gravel sumps in sub-grade, where specified on construction documents.
 - c. PVC Catch Basins and Cleanouts shall be sized as shown on the plans or as required for necessary pipe connections. All PVC cleanouts shall have standard, solid lids and PVC Catch Basins shall have standard domed grates. All PVC structures shall be manufactured with black colored PVC or painted black.
 - d. All Control Structure boxes shall be precast concrete with traffic rated heavy duty solid frame and cover. Manhole frame and cover shall be heavy-duty model, undipped, solid plated, with neoprene gasket installed as manufactured
 - e. Heavy Duty Trench drain grates /covers and frames shall be cast iron, heavy-duty traffic rated and sized as shown on the plans. Trench drain grates and covers shall be bolted to the frame.
 - f. Manhole frame and cover shall be heavy-duty model EJIW V-1326, Neenah R-1649, Sigma, Deeter, or equal as approved by the Professional.
 - g. Manhole frame and cover shall be heavy-duty model, undipped, solid planten, with neoprene gasket installed as manufactured.

2. Domed Risers: PVC domed grate and shall be sized as shown on plans or as required for necessary pipe connections.
3. Observation wells shall be six-inch (6") inside diameter rigid Schedule 40 PVC pipe in upper section, with solid cap. Slotted sections shall be six-inch (6") PVC slotted well with maximum 0.02 slots and attached plug, Atlantic Screen and Manufacturing item # OES40600, Jet Stream 6" Schedule 40, or NAPCO 6" Schedule 40 ¼" slot spacing or approved equivalent.
 - a. Covers for observation wells shall be lockable ductile iron with gray iron frames, East Jordan Ironworks product #00157026, Atlantic Supply product # A0721-188, Environ Design Products product #MWL8008SM, or approved equivalent. Cover and/or frame shall be stamped "MONITORING WELL". Bolts shall be machine head stainless steel with hex key insert as appropriate. Bolts shall be installed clean and free of grit or debris and coated using white lithium grease or equivalent metal-to-metal lubricant and rust protector prior to initial installation.

C. Subsurface Infiltration Beds

1. All aggregates within infiltration beds shall be clean and thoroughly washed and shall meet the following:
 - a. Maximum Wash Loss of 0.5% (ASTM C117)
 - b. Minimum Durability Index of 35 (ASTM D3744)
 - c. L.A. abrasion loss, 30% maximum. (ASTM C131 and C535)
 - d. Aggregate shall be 100% crushed material.
 - e. Fractured Faces, 1 side 98% minimum, 2 sides 90% minimum (ASTM D5821).
2. Unless otherwise approved by the Professional, coarse aggregate for the infiltration beds shall be uniformly graded with the following gradation (AASHTO size no. 3)1:

U.S. Standard Sieve Size	Percent Passing
2 ½" (63mm)	100
2" (50mm)	90-100
1 ½" (37.5mm)	35-70
1" (25mm)	0-15
½" (12.5mm)	0-5

3. Choker base course aggregate for infiltration beds shall have the following gradation (AASHTO size number 57):

U.S. Standard Sieve Size	Percent Passing
1 ½" (37.5mm)	100
1" (25mm)	95-100
½" (12.5mm)	25-60
4 (4.75mm)	0-10
8 (2.36mm)	0-5

4. Non-woven geotextile (drainage filter fabric) shall conform to the following:
 - a. Minimum flow rate of 110 gal/min/ft² ASTM D-4491
 - b. Grab tensile strength min 150 lb ASTM D-4632
 - c. Mullen Burst strength min 300 psi ASTM D-3786

- d. Puncture strength min 90 lb ASTM D-4833
 - e. Apparent opening size 60-70 US Sieve ASTM D-4751
 - f. Non-woven geotextile shall be Mirafi 160N, TerraTex NO6, Geotex 601, US Fabrics US 160NW, or equal as approved by the Professional.
5. Waterproof Liner for Waterstop shall be 30 mil PVC or HDPE minimum.
- D. Erosion Control Blanket
- 1. Double-Net Straw-Coconut Rolled Erosion Control Blanket
- E. Permanent Reinforcement Mat
- 1. Permanent turf reinforcement mat shall be NAG VMax SC250, US Erosion US-2P10, Propex Landlok TRM 450, Eat Cost Erosion Control ECP-2, or equal as approved by the Professional.
- F. Anti-Seep Collar
- 1. Anti-Seep Collars shall be quarter-inch (1/4") HDPE or Polyethylene sheets cut to the dimensions indicated and installed as indicated on the Drawings. All metal fittings or attachments used shall be nylon or stainless steel (Grade 304 or better). Plastic sealant for weld shall be as suggested by manufacturer.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine the areas and conditions under which work is to be performed and notify the Professional in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.

3.2 EXCAVATION AND BACKFILL

- A. Grade utility trench bottom to a smooth, firm, stable and rock-free foundation. Remove unstable, soft, and unsuitable materials, as determined by the Professional, and backfill with clean granular material to indicated level, per PennDOT Specification 408.

3.3 DEMOLITION OF EXISTING UTILITIES

- A. In the event that plumbing or piping systems must be demolished, no lines shall be left open ended. All lines to be demolished shall be terminated with either a valve and a cap or plug, or with just a cap or plug.
- B. All caps or plugs shall be installed to withstand the flow and pressure of the line that it is terminating in the event that the line is reenergized.

3.4 INSTALLATION OF PIPE

- A. The Contractor shall stake out all proposed lines prior to the start of work. The location of said

lines shall conform to the locations shown on the drawings. Any problems with alignments shown on the drawings shall be brought to the attention of the Professional. Any changes in alignments shown on the drawings must be approved by the Professional. Staked alignments shall be approved in the field before the start of work.

1. All piping shall be cut accurately for fabrication to measurements established at the construction site. Remove all foreign matter or dirt from the inside of the pipe before it is lowered into position.
2. Align piping in the trench in accordance with the instructions of the pipe and pipe joint manufacturers. Follow manufacturer's instructions in joining pipes. All piping shall be worked into place without springing and/or forcing.
3. During and following installation, protect inlets and all piping from sediment and other foreign matter by covering, capping, installation of silt sacks or haybales, and whatever other measures are required.
4. Repair any damaged sections of pavement that may result from construction activities, according to PennDOT specifications.
5. Storm water drainage system shall be provided for all roof and area drains and be connected into the site storm system.

3.5 INSTALLATION OF INFILTRATION BEDS

- A. Client Agency and Professional shall be notified at least 24 hours prior to all infiltration bed work.
- B. Client Agency and Professional shall be contacted upon final bed bottom grading prior to installation of geotextile and aggregate. Notify the Professional 72 hours prior to sub-grade completion. Geotextile shall not be placed until Professional has observed sub-grade conditions.
- C. Subgrade preparation
 1. Existing subgrade under bed areas shall NOT be compacted or subject to construction equipment traffic prior to geotextile and stone bed placement. Excavators/backhoes should be used to excavate the bed area such that equipment is never running on exposed bed bottoms.
 2. Where erosion of subgrade has caused accumulation of fine materials and/or surface ponding, this material shall be removed with light equipment and the underlying soils loosened/scarified to a minimum depth of 6 inches. Overly dense or compacted soils should also be loosened/scarified to a minimum depth of 6 inches.
 3. Bring subgrade of stone infiltration bed to line, grade, and elevations indicated.
- D. Infiltration Bed Installation
 1. Upon completion of subgrade work, the Professional shall be notified and shall inspect at his or her discretion before proceeding with infiltration bed installation.
 2. Geotextile and infiltration bed aggregate shall be placed immediately after approval of subgrade preparation. Any accumulation of debris or sediment which has taken place after approval of subgrade shall be removed prior to installation of geotextile at no extra cost to the Client Agency.
 3. Place geotextile in accordance with manufacturer's standards and recommendations. Adjacent strips of geotextile shall overlap a minimum of sixteen inches (16"). Secure geotextile at least four feet (4') outside of bed and take any steps necessary to prevent any

- runoff or sediment from entering the storage bed.
4. Install coarse aggregate in 8-inch maximum lifts. Lightly Compact each layer with equipment, keeping equipment movement over storage bed subgrades to a minimum. Install aggregate to grades indicated on the drawings.
 5. Following placement of bed aggregate, the geotextile shall be folded over the top of the entire bed and secured in place.
 6. The infiltration bed area shall be backfilled with fill as indicated on the contract documents.

END OF SECTION 334100

APPENDICES

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF LABOR AND INDUSTRY
Bureau of Occupational and Industrial Safety



UNIFORM CONSTRUCTION CODE
BUILDING PERMIT

The plans and specifications for the building or structure named below have been reviewed by the Department of Labor and Industry and found to be in compliance with the Pennsylvania Construction Code Law (1999, November 10, P.L. 491, No. 45).

Permit Number	202101284
Permit Holder	MEGAN STRENSKI
Address	1600 WALNUT ST 2ND FLOOR PHILADELPHIA PA 19103
Building/Structure Name	HICKORY RUN STATE PARK LOOP C LATRINE IMPROVEMENTS
Building Address	3 FAMILY CAMP RD WHITE HAVEN 18661
Political Subdivision:	KIDDER TOWNSHIP
County:	CARBON
Approved use and occupancy classification(s)	B
Approved construction type	VB
Plan code	BUILDING

This permit authorizes construction of the above named building or structure in accordance with the Pennsylvania Construction Code Act, its regulations and all plans and specifications approved by the Department. A copy of this permit shall be retained at the work site until the completion of all construction.

File Number	542134
Date Issued	12/17/2021

A handwritten signature in black ink, appearing to read "Joseph C. Martin".

Joseph C. Martin
Building Code Official

A highway access occupancy permit is required under S420 of the State highway Law (36 P.S. 670-420) before driveway access to a commonwealth highway is permitted.

Uniform Construction Code (UCC)

INSPECTION LOG

THIS LOG MUST BE RETAINED AT THE CONSTRUCTION OR DEMOLITION SITE UNTIL THE COMPLETION OF ALL WORK AND MUST BE MADE AVAILABLE TO ALL DEPARTMENT CODE OFFICIALS, UPON REQUEST. All Inspections preceded by a "Y" must be performed in accordance with the approved construction documents and section 403.45 of the UCC before a "Certificate of Compliance or a Certificate of Occupancy and Use" will be issued. This document's only use is to inform the permit holder of required inspections and is to enable L&I staff to record the completion of these inspections during the course of the construction process. It is not intended to document the fulfillment of all required UCC obligations or establish the right to legally occupy the building or structure named below.

Drawing Index Number: 202101284
Building/Structure Name: HICKORY RUN STATE PARK
Address: 3 FAMILY CAMP RD
WHITE HAVEN PA 18661

File Number: 542134

Requests for inspections must be made in conformance with the Inspection Procedures Statement and should be directed to the inspector named below.

Inspector: Samuel Marranca (570)916-7647 smarranca@pa.gov				
If unavailable, contact Central Office: 717-787-1291 jecole@pa.gov				
REQUIRED	INSPECTION	INSPECTOR (PRINT)	INSPECTOR (SIGNATURE)	DATE ACCEPTED
Y	Footing Environment			
Y	Foundation			
	Concrete Under Slab/Floor			
	Underground Plumbing			
	Underground Mechanical			
Y	Underground Electrical			
Y	Plumbing Rough-in			
Y	Mechanical Rough-in			
Y	Electrical Rough-in			
D	Framing			
Y	Insulation			
	Fire Protection			
Y	Accessibility Final			
Y	Energy Final			
Y	Mechanical Final			
Y	Electrical Final			
Y	Plumbing Final			
Y	Building Final			
	Demolition Final			
	Alterations Final			
	Sign Final			
	Structure Final			

COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF LABOR AND INDUSTRY

Bureau of Occupational and Industrial Safety



UNIFORM CONSTRUCTION CODE

BUILDING PERMIT

The plans and specifications for the building or structure named below have been reviewed by the Department of Labor and Industry and found to be in compliance with the Pennsylvania Construction Code Law (1999, November 10, P.L. 491, No. 45).

Permit Number	202101285
Permit Holder	MEGAN STRENSKI
Address	1600 WALNUT STREET 2ND FLOOR PHILADELPHIA PA 19103
Building/Structure Name	HICKORY RUN STATE PARK SHEHAQUA GROUP CAMP LATRINE IMPROVEMENTS
Building Address	3 FAMILY CAMP RD WHITE HAVEN 18661
Political Subdivision:	KIDDER TOWNSHIP
County:	CARBON
Approved use and occupancy classification(s)	B
Approved construction type	VB
Plan code	BUILDING

This permit authorizes construction of the above named building or structure in accordance with the Pennsylvania Construction Code Act, its regulations and all plans and specifications approved by the Department. A copy of this permit shall be retained at the work site until the completion of all construction.

File Number	544495
Date Issued	12/17/2021

Joseph C. Martin
Building Code Official

A highway access occupancy permit is required under S420 of the State highway Law (36 P.S. 670-420) before driveway access to a commonwealth highway is permitted.

Uniform Construction Code (UCC)
INSPECTION LOG

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Drawing Index Number: 202101285 **File Number:** 544495
Building/Structure Name: HICKORY RUN STATE PARK
Address: 3 FAMILY CAMP RD
WHITE HAVEN PA 18661

Requests for inspections must be made in conformance with the Inspection Procedures Statement and should be directed to the inspector named below.

Inspector: Samuel Marranca (570)916-7647 smarranca@pa.gov				
If unavailable, contact Central Office: 717-787-1291 jecole@pa.gov				
REQUIRED	INSPECTION	INSPECTOR (PRINT)	INSPECTOR (SIGNATURE)	DATE ACCEPTED
Y	Footing Environment			
Y	Foundation			
	Concrete Under Slab/Floor			
	Underground Plumbing			
	Underground Mechanical			
Y	Underground Electrical			
Y	Plumbing Rough-in			
Y	Mechanical Rough-in			
Y	Electrical Rough-in			
D	Framing			
Y	Insulation			
	Fire Protection			
Y	Accessibility Final			
Y	Energy Final			
Y	Mechanical Final			
Y	Electrical Final			
Y	Plumbing Final			
Y	Building Final			
	Demolition Final			
	Alterations Final			
	Sign Final			
	Structure Final			

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF LABOR AND INDUSTRY
Bureau of Occupational and Industrial Safety



UNIFORM CONSTRUCTION CODE
BUILDING PERMIT

The plans and specifications for the building or structure named below have been reviewed by the Department of Labor and Industry and found to be in compliance with the Pennsylvania Construction Code Law (1999, November 10, P.L. 491, No. 45).

Permit Number	202101286
Permit Holder	MEGAN STRENSKI
Address	1600 WALNUT ST 2ND FLOOR PHILADELPHIA PA 19103
Building/Structure Name	HICKORY RUN STATE PARK DADDY ALLEN GROUP CAMP LATRINE IMPROVEMENTS
Building Address	3 FAMILY CAMP RD WHITE HAVEN 18661
Political Subdivision:	KIDDER TOWNSHIP
County:	CARBON
Approved use and occupancy classification(s)	B
Approved construction type	VB
Plan code	BUILDING

This permit authorizes construction of the above named building or structure in accordance with the Pennsylvania Construction Code Act, its regulations and all plans and specifications approved by the Department. A copy of this permit shall be retained at the work site until the completion of all construction.

File Number	544497
Date Issued	12/17/2021

A handwritten signature in black ink, appearing to read "Joseph C. Martin".

Joseph C. Martin
Building Code Official

A highway access occupancy permit is required under S420 of the State highway Law (36 P.S. 670-420) before driveway access to a commonwealth highway is permitted.

Uniform Construction Code (UCC)

INSPECTION LOG

THIS LOG MUST BE RETAINED AT THE CONSTRUCTION OR DEMOLITION SITE UNTIL THE COMPLETION OF ALL WORK AND MUST BE MADE AVAILABLE TO ALL DEPARTMENT CODE OFFICIALS, UPON REQUEST. All Inspections preceded by a "Y" must be performed in accordance with the approved construction documents and section 403.45 of the UCC before a "Certificate of Compliance or a Certificate of Occupancy and Use" will be issued. This document's only use is to inform the permit holder of required inspections and is to enable L&I staff to record the completion of these inspections during the course of the construction process. It is not intended to document the fulfillment of all required UCC obligations or establish the right to legally occupy the building or structure named below.

Drawing Index Number: 202101286 **File Number:** 544497
Building/Structure Name: HICKORY RUN STATE PARK
Address: 3 FAMILY CAMP RD
WHITE HAVEN PA 18661

Requests for inspections must be made in conformance with the Inspection Procedures Statement and should be directed to the inspector named below.

Inspector: Samuel Marranca (570)916-7647 smarranca@pa.gov				
If unavailable, contact Central Office: 717-787-1291 jecole@pa.gov				
REQUIRED	INSPECTION	INSPECTOR (PRINT)	INSPECTOR (SIGNATURE)	DATE ACCEPTED
Y	Footing Environment			
Y	Foundation			
	Concrete Under Slab/Floor			
	Underground Plumbing			
	Underground Mechanical			
Y	Underground Electrical			
Y	Plumbing Rough-in			
Y	Mechanical Rough-in			
Y	Electrical Rough-in			
D	Framing			
Y	Insulation			
	Fire Protection			
Y	Accessibility Final			
Y	Energy Final			
Y	Mechanical Final			
Y	Electrical Final			
Y	Plumbing Final			
Y	Building Final			
	Demolition Final			
	Alterations Final			
	Sign Final			
	Structure Final			

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF LABOR AND INDUSTRY
Bureau of Occupational and Industrial Safety



UNIFORM CONSTRUCTION CODE
BUILDING PERMIT

The plans and specifications for the building or structure named below have been reviewed by the Department of Labor and Industry and found to be in compliance with the Pennsylvania Construction Code Law (1999, November 10, P.L. 491, No. 45).

Permit Number	202101287
Permit Holder	MEGAN STRENSKI
Address	1600 WALNUT ST 2ND FLR PHILADELPHIA PA 19103
Building/Structure Name	HICKORY RUN STATE PARK GROUP TENT CAMP LATRINE IMPROVEMENTS
Building Address	3 FAMILY CAMP RD WHITE HAVEN 18661
Political Subdivision:	KIDDER TOWNSHIP
County:	CARBON
Approved use and occupancy classification(s)	B
Approved construction type	VB
Plan code	BUILDING

This permit authorizes construction of the above named building or structure in accordance with the Pennsylvania Construction Code Act, its regulations and all plans and specifications approved by the Department. A copy of this permit shall be retained at the work site until the completion of all construction.

File Number	544498
Date Issued	12/17/2021

A handwritten signature in black ink, appearing to read "Joseph C. Martin".

Joseph C. Martin
Building Code Official

A highway access occupancy permit is required under S420 of the State highway Law (36 P.S. 670-420) before driveway access to a commonwealth highway is permitted.

Uniform Construction Code (UCC)

INSPECTION LOG

THIS LOG MUST BE RETAINED AT THE CONSTRUCTION OR DEMOLITION SITE UNTIL THE COMPLETION OF ALL WORK AND MUST BE MADE AVAILABLE TO ALL DEPARTMENT CODE OFFICIALS, UPON REQUEST. All Inspections preceded by a "Y" must be performed in accordance with the approved construction documents and section 403.45 of the UCC before a "Certificate of Compliance or a Certificate of Occupancy and Use" will be issued. This document's only use is to inform the permit holder of required inspections and is to enable L&I staff to record the completion of these inspections during the course of the construction process. It is not intended to document the fulfillment of all required UCC obligations or establish the right to legally occupy the building or structure named below.

Drawing Index Number: 202101287 **File Number:** 544498
Building/Structure Name: HICKORY RUN STATE PARK
Address: 3 FAMILY CAMP RD
WHITE HAVEN PA 18661

Requests for inspections must be made in conformance with the Inspection Procedures Statement and should be directed to the inspector named below.

Inspector: Samuel Marranca (570)916-7647 smarranca@pa.gov				
If unavailable, contact Central Office: 717-787-1291 jecole@pa.gov				
REQUIRED	INSPECTION	INSPECTOR (PRINT)	INSPECTOR (SIGNATURE)	DATE ACCEPTED
Y	Footing Environment			
Y	Foundation			
	Concrete Under Slab/Floor			
	Underground Plumbing			
	Underground Mechanical			
Y	Underground Electrical			
Y	Plumbing Rough-in			
Y	Mechanical Rough-in			
Y	Electrical Rough-in			
D	Framing			
Y	Insulation			
	Fire Protection			
Y	Accessibility Final			
Y	Energy Final			
Y	Mechanical Final			
Y	Electrical Final			
Y	Plumbing Final			
Y	Building Final			
	Demolition Final			
	Alterations Final			
	Sign Final			
	Structure Final			

Megan Strenski

From: Marc Henderson <march@melioradesign.com>
Sent: Thursday, October 27, 2022 5:05 PM
To: Todd Woodward
Cc: Megan Strenski
Subject: FW: [External] Hickory Run - Final Plan Response to Comments
Attachments: RE: Hickory Run - Final Plan Response to Comments

Todd,
See below for indication from the Township that they were ready for final plans.

Marc Henderson, PE | Meliora Design

P. 610.933.0123 | C. 352.213.7825

From: Cindy Norato <cnorato@kiddertownship.org>
Sent: Monday, October 17, 2022 8:08 AM
To: Marc Henderson <march@melioradesign.com>
Subject: FW: [External] Hickory Run - Final Plan Response to Comments

Marc,

If all the markups on the responses from Dave, see below & attached. Bring in the 7 copies for signatures. BE SURE ALL SIGNATURES ARE IN ORIGINAL BLACK INK!!.

Sincerely,

Cindy Norato

*Planning Administrator/ Zoning Officer
Kidder Township*

10 Lake Harmony Road
P.O. Box 576
Lake Harmony, PA 18624
Phone: (570) 722-0107
Fax: (570) 722-5636
e-mail: cnorato@kiddertownship.org
web: www.kiddertownship.org

From: Walasavage, David <David.Walasavage@arroconsulting.com>
Sent: Sunday, October 16, 2022 10:38 AM
To: Cindy Norato <cnorato@kiddertownship.org>; Marc Henderson <march@melioradesign.com>
Cc: Ryurchak@ptd.net
Subject: RE: [External] Hickory Run - Final Plan Response to Comments

Cindy,



**AUTHORIZATION TO DISCHARGE UNDER THE
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
INDIVIDUAL PERMIT FOR DISCHARGES OF
STORMWATER ASSOCIATED WITH CONSTRUCTION ACTIVITIES**

NPDES PERMIT NO: PAD130035

In compliance with the provisions of the Clean Water Act, 33 U.S.C. Section 1251 et seq. (the Act) and Pennsylvania's Clean Streams Law, as amended, 35 P.S. Section 691.1 et seq.,

Permittee

**Commonwealth of Pennsylvania
Department of General Services
Arsenal Building 1800 Herr Street
Harrisburg, PA 17103**

Project Site

**Hickory Run State Park Latrine Improvements
Kidder Township, Carbon County
Earth Disturbance: 2.54 acres**

is authorized to discharge from an earth disturbance activity to **Hickory Run (HQ-CWF, MF)** in accordance with effluent limitations, monitoring requirements and other conditions set forth in Parts A, B and C herein.

THIS PERMIT SHALL BECOME EFFECTIVE ON August 16, 2022

THIS PERMIT SHALL EXPIRE AT MIDNIGHT ON August 15, 2027

The authority granted by this permit is subject to the following further qualifications:

1. If there is a conflict between the application, its supporting documents and/or amendments and the terms and conditions of this permit, the terms and conditions shall apply.
2. Failure to comply with the terms, conditions or effluent limitations of this permit is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or for denial of a permit renewal application. (40 CFR 122.41(a))
3. A complete application for renewal of this permit, or notice of intent to cease discharging by the expiration date, must be submitted to DEP at least 180 days prior to the above expiration date (unless permission has been granted by DEP for submission at a later date), using the appropriate NPDES permit application form. (40 CFR 122.41(b), 122.21(d))

In the event that a timely and complete application for renewal has been submitted and DEP is unable, through no fault of the permittee, to reissue the permit before the above expiration date, the terms and conditions of this permit will be automatically continued and will remain fully effective and enforceable against the discharger until DEP takes final action on the pending permit application. (25 Pa. Code §§ 92a.7(b), (c))

ISSUANCE DATE:

August 16, 2022

Carl J. DeLuca

**Carl Deluca
Acting Program Manager
Waterways & Wetlands Program**

PART A – EFFLUENT LIMITATIONS, RECORDKEEPING AND REPORTING REQUIREMENTS

I. DEFINITIONS

Alternative BMP means a best management practice that is not identified in the Department's Erosion and Sediment Pollution Control Program Manual (363-2134-008) or Pennsylvania Stormwater Best Management Practices Manual (363-0300-002) but may be proposed and approved by DEP to achieve compliance with the provisions of Chapter 102, under the authority of 25 Pa. Code § 102.11(b).

Approximate original condition means the pre-construction hydrologic condition, general surface configuration, and drainage pattern of the land prior to earth disturbance. Restoration from forest to meadow is considered approximate original condition under this permit.

Best Management Practices (BMPs) means activities, facilities, measures, planning or procedures used to minimize accelerated erosion and sedimentation and manage stormwater to protect, maintain, reclaim, and restore the quality of waters and the existing and designated uses of waters within this Commonwealth before, during, and after earth disturbance activities. (25 Pa. Code § 102.1)

Clean fill means uncontaminated, non-water soluble, non-decomposable inert solid material. The term does not include materials placed in or on waters of the Commonwealth unless otherwise authorized. (25 Pa. Code § 271.1)

Clean Streams Law means the Act of June 22, 1937, P.L. 1987, No. 394, as amended. (35 P.S. §§ 691.1 to 691.1001).

Clean Water Act means the Federal Water Pollution Control Act, as amended. (33 U.S.C. §§ 1251 to 1387).

County Conservation District or CCD means a conservation district, as defined in section 3(c) of the Conservation District Law (3 P.S. § 851(c)), which has the authority under a delegation agreement executed with DEP to administer and enforce all or a portion of the erosion, sediment, and stormwater management program in this Commonwealth. (25 Pa. Code § 102.1)

DEP means the Pennsylvania Department of Environmental Protection.

DEP/CCD means either DEP or a CCD or both. Where the term DEP/CCD is used to describe an action that will or may be taken, the term generally applies to both. Where the term DEP/CCD is used to describe the agency that must receive applications, reports, notifications or other information required by the permit, the term generally applies to the agency that is the recipient of the application.

Designated uses means those uses specified in 25 Pa. Code §§ 93.4(a) and 93.9a—93.9z for each water body or segment, whether or not they are being attained, to be achieved as part of Pennsylvania's water quality standards. (25 Pa. Code § 93.1)

Discharge point means all engineered structures, drainageways and areas of concentrated flow where runoff leaves a project site, except for areas of shallow concentrated flow that are controlled by perimeter BMPs. Discharge points are not only pipes (outlets from BMPs) but also include areas where stormwater flows will concentrate by design and areas of concentrated flow prior to level spreaders or other diffusion of flows. Discharge points may be situated at or near surface waters or at another location, at or prior to the project site boundary.

Disturbed area means unstabilized land area where an earth disturbance activity is occurring or has occurred. (25 Pa. Code § 102.1)

Earth disturbance activity means a construction or other human activity which disturbs the surface of the land, including land clearing and grubbing, grading, excavations, embankments, land development, agricultural plowing or tilling, operation of animal heavy use areas, timber harvesting activities, road maintenance activities, oil and gas activities, well drilling, mineral extraction, and the moving depositing, stockpiling, or storing of soil, rock or earth materials. (25 Pa. Code § 102.1)

Environmental due diligence means investigative techniques, including, but not limited to, visual property inspections, electronic database searches, review of ownership and use history of property, Sanborn maps, environmental questionnaires, transaction screens, analytical testing, environmental assessments or audits.

Erosion and Sediment Control (E&S) Plan means a site-specific plan consisting of both drawings and a narrative that identifies BMPs to minimize accelerated erosion and sedimentation before, during and after earth disturbance activities. (25 Pa. Code § 102.1)

Exceptional Value waters means surface waters of high quality which satisfy 25 Pa. Code § 93.4b(b) (relating to antidegradation). (25 Pa. Code § 93.1)

Existing uses means those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in Pennsylvania's water quality standards. (25 Pa. Code § 93.1)

High Quality waters means surface waters having quality which exceeds levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water by satisfying 25 Pa. Code § 93.4b(a). (25 Pa. Code § 93.1)

Licensed professional means professional engineers, landscape architects, geologists and land surveyors licensed to practice in this Commonwealth. (25 Pa. Code § 102.1)

Municipal Separate Storm Sewer System (MS4) means all separate storm sewers that are defined as "large" or "medium" or "small" municipal separate storm sewer systems pursuant to 40 CFR §§ 122.26(b)(4), (b)(7), and (b)(16), respectively, or designated under 40 CFR § 122.26(a)(1)(v). (25 Pa. Code § 92a.32(a) and 40 CFR § 122.26(b)(18))

Municipality means a city, town, borough, county, township, school district, institution, authority or other public body created by or pursuant to State law and having jurisdiction over disposal of sewage, industrial wastes or other wastes. (25 Pa. Code § 92a.2)

New discharge means a new source as defined at 40 CFR § 122.2

Non-stormwater discharges means discharges that do not originate from storm events. They can include, but are not limited to, discharges of process water, air conditioner condensate, non-contact cooling water, pavement wash water, external building washdown, irrigation water, or uncontaminated ground water or spring water.

Notice of Termination (NOT) means a request, on a form provided by DEP, to terminate coverage under a General or Individual NPDES Permit for Stormwater Discharges Associated with Construction Activities or other permits under Chapter 102. (25 Pa. Code § 102.1)

Off-site construction support activities or off-site support activities means activities providing support for construction and earth disturbance activities covered by this permit, including but not limited to concrete or asphalt batch plants, equipment staging yards, material storage areas, excavated material disposal areas (spoil), borrow areas, stockpiling of topsoil, transfer of topsoil to other locations, and turnaround areas.

Operator means a person who has one or more of the following: (i) oversight responsibility of earth disturbance activity on a project site or a portion thereof who has the ability to make modifications to the E&S Plan, PCSM Plan or site specifications, (ii) day-to-day operational control over earth disturbance activity on a project site or a portion thereof to ensure compliance with the E&S Plan or PCSM Plan. (25 Pa. Code § 102.1)

Permittee means a person who has coverage under this permit. The term permittee is also used to describe operators who are co-permittees, to the extent that co-permittees are jointly and severally liable for non-compliance with this permit.

Permanent Stabilization means long-term protection of soil and water resources from accelerated erosion. (25 Pa. Code § 102.1)

Person means any operator, individual, public or private corporation, partnership, association, municipality or political subdivision of this Commonwealth, institution, authority, firm, trust, estate, receiver, guardian, personal

representative, successor, joint venture, joint stock company, fiduciary; department, agency or instrumentality of State, Federal or local government, or an agent or employee thereof; or any other legal entity. (25 Pa. Code § 102.1)

Point source means a discernible, confined and discrete conveyance, including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, Concentrated Aquatic Animal Production (CAAP) facility, Concentrated Animal Feeding Operation (CAFO), landfill leachate collection system, or vessel or other floating craft, from which pollutants are or may be discharged. (25 Pa. Code §§ 92a.2, 92a.3(b)(1) and 40 CFR § 122.2)

Pollutant means any contaminant or other alteration of the physical, chemical, biological or radiological integrity of surface water that causes or has the potential to cause pollution as defined in Section 1 of the Clean Streams Law (35 P.S. § 691.1). (25 Pa. Code § 102.1)

Post-Construction Stormwater Management (PCSM) Plan means a site-specific plan consisting of both drawings and a narrative that identifies BMPs to manage changes in stormwater runoff volume, rate and water quality after earth disturbance activities have ended and the project site is permanently stabilized. (25 Pa. Code § 102.1)

Preparedness, Prevention and Contingency (PPC) Plan means a written plan that identifies an emergency response program, material and waste inventory, spill and leak prevention and response, inspection program, housekeeping program, security and external factors, and that is developed and implemented at the construction site to control potential discharges of pollutants other than sediment into waters of this Commonwealth. (25 Pa. Code § 102.1)

Project site means the entire area of activity, development, lease or sale including (i) the area of earth disturbance activity, (ii), the area planned for an earth disturbance activity, and (iii) other areas which are not subject to an earth disturbance activity. (25 Pa. Code § 102.1)

Regulated fill means soil, rock, stone, dredged material, used asphalt, historic fill, and brick, block or concrete from construction and demolition activities that is separate from other waste and recognizable as such that has been affected by a spill or release of a regulated substance and the concentrations of regulated substances exceed the values in Tables FP-1a and b of DEP's Management of Fill Policy (258-2182-773).

Roadway Standard means BMPs and project site conditions that may be utilized by an applicant for managing sheet or dispersed runoff flows for the purpose of complying with 25 Pa. Code § 102.8 and for obtaining permit coverage.

Rooftop Standard means BMPs and project site conditions that may be utilized by an applicant for managing concentrated runoff flows for the purpose of complying with 25 Pa. Code § 102.8 and for obtaining permit coverage.

Site Restoration means, for the purpose of this permit, a project that will restore the area of earth disturbance to approximate original condition or will otherwise involve no change or a decrease in the area of pre-construction impervious surfaces, including (i) environmental enhancement projects, such as wetland mitigation projects, stormwater retrofits and stream restoration projects; (ii) bike paths, walking paths and trails associated with vegetated open space (natural grass) or forests; (iii) sidewalk construction projects that are not part of road or highway construction or reconstruction project or a common plan of development or sale; (iv) slope stabilization projects not associated with a road maintenance activity; (v) slope flattening, not associated with a road maintenance activity, that changes the grade of the site, but does not significantly change the runoff characteristics; (vi) spoil areas that will be covered with vegetation; (vii) land clearing and grading for the sole purpose of creating vegetated open space such as parks and fields, excluding projects that alter hydrology from pre- to post-construction conditions; (viii) athletic fields (natural grass) that do not include the construction or reconstruction of impervious area and do not alter hydrology from pre- to post-construction conditions; and (ix) demolition projects where vegetation will be established and no redevelopment is planned.

Site Restoration PCSM BMP means restoration of post-construction land cover to approximate pre-construction land cover with respect to stormwater runoff properties.

Snowmelt means the conversion of snow into overland stormwater and ground water flow as a result of warmer temperatures.

Stabilization means the proper placing, grading, constructing, reinforcing, lining, and covering of soil, rock or earth to ensure their resistance to erosion, sliding or other movement. (25 Pa. Code § 102.1)

Stormwater means runoff from precipitation, snowmelt, surface runoff and drainage. (25 Pa. Code § 102.1)

Surface waters means perennial and intermittent streams, rivers, lakes, reservoirs, ponds, wetlands, springs, natural seeps and estuaries, excluding water at facilities approved for wastewater treatment such as wastewater treatment impoundments, cooling water ponds and constructed wetlands used as part of a wastewater treatment process. (25 Pa. Code § 102.1)

Toxic pollutant means those pollutants, or combinations of pollutants, including disease-causing agents, which after discharge and upon exposure, ingestion, inhalation or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains may, on the basis of information available to DEP cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions, including malfunctions in reproduction, or physical deformations in these organisms or their offspring. (25 Pa. Code § 92a.2)

Urbanized area (UA) means land area comprising one or more places (central place(s)) and the adjacent densely settled surrounding area (urban fringe) that together have a residential population of at least 50,000 and an overall population density of at least 1,000 people per square mile, as defined by the United States Bureau of the Census and as determined by the latest available decennial census. The UA outlines the extent of automatically regulated areas.

Waters of the Commonwealth means rivers, streams, creeks, rivulets, impoundments, ditches, water courses, storm sewers, lakes, dammed water, ponds, springs and all other bodies or channels of conveyance of surface and underground water, or parts thereof, whether natural or artificial, within or on the boundaries of this Commonwealth. (35 P.S. § 691.1)

Wetlands means areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions, including swamps, marshes, bogs and similar areas. (25 Pa. Code § 105.1)

II. EFFLUENT LIMITATIONS

A. BMPs.

Except as required by 25 Pa. Code § 102.11(c), this permit establishes narrative performance-based effluent limitations in the form of BMPs identified in E&S Plans, PCSM Plans, and PPC Plans, which control the volume, rate, and quality of stormwater runoff and associated pollutants from being discharged into surface waters, and which replicate pre-construction infiltration and runoff conditions to the maximum extent practicable.

B. Technology-Based Effluent Limitations.

1. The permittee shall design, install and maintain effective erosion controls and sediment controls, and PCSM BMPs, to minimize the discharge of pollutants. At a minimum, such controls must be designed, installed and maintained to: (25 Pa. Code § 102.11(c) and 40 CFR § 450.22(c))
 - a. Control stormwater volume and velocity to minimize soil erosion in order to minimize pollutant discharges.
 - b. Control stormwater discharges, including both peak flow rates and total stormwater volume, to minimize channel and streambank erosion and scour in the immediate vicinity of discharge points.
 - c. Minimize the amount of soil exposed during construction activity.
 - d. Minimize the disturbance of slopes exceeding 15%.
 - e. Minimize sediment discharges from the site. The design, installation and maintenance of erosion and sediment controls must address factors such as the amount, frequency, intensity and duration of precipitation, the nature of resulting stormwater runoff, and soil characteristics, including the range of soil particle sizes expected to be present on the site.
 - f. Provide and maintain natural buffers around surface waters of the Commonwealth, direct stormwater to vegetated areas and maximize stormwater infiltration to reduce pollutant discharges, unless infeasible.
 - g. Avoid or minimize soil compaction in all areas where BMPs utilizing infiltration to manage stormwater is proposed. If the areas planned for infiltration BMPs are compromised through compaction or other means, the permittee shall conduct soil testing to verify that the BMP will perform as designed and implement measures to decompact the soils, as applicable.
 - h. Preserve topsoil unless the intended function of a specific area of the project site dictates that the topsoil be disturbed or removed.
2. Soil Stabilization. (25 Pa. Code § 102.22)
 - a. Temporary Stabilization.
 - i. Upon temporary cessation of an earth disturbance activity or any stage or phase of an activity where a cessation of earth disturbance activities will exceed 4 days, the site shall be immediately seeded, mulched, or otherwise protected from accelerated erosion and sedimentation pending future earth disturbance activities.
 - ii. For an earth disturbance activity or any stage or phase of an activity to be considered temporarily stabilized, the disturbed areas shall be covered with one of the following:
 - (1) A minimum uniform coverage of mulch and seed, with a density capable of resisting accelerated erosion and sedimentation.
 - (2) An acceptable BMP which temporarily minimizes accelerated erosion and sedimentation.

- b. Permanent Stabilization – Upon final completion of an earth disturbance activity or any stage or phase of an activity, the site shall immediately have topsoil restored, replaced, or amended, seeded, mulched or otherwise permanently stabilized and protected from accelerated erosion and sedimentation.
 - i. E&S BMPs shall be implemented and maintained until the permanent stabilization is completed. Once permanent stabilization has been established, the temporary E&S BMPs shall be removed. Any areas disturbed in the act of removing temporary E&S BMPs shall be permanently stabilized upon completion of the temporary E&S BMP removal activity.
 - ii. For an earth disturbance activity or any stage or phase of an activity to be considered permanently stabilized, the disturbed areas shall be covered with one of the following:
 - (1) A minimum uniform 70% perennial vegetative cover, with a density capable of resisting accelerated erosion and sedimentation.
 - (2) An acceptable BMP which permanently minimizes accelerated erosion and sedimentation.
 - c. The permittee shall not utilize seed mixtures containing invasive species or species that may be harmful to native plant communities.
3. Discharges from dewatering activities, including discharges from dewatering of trenches and excavations, are prohibited unless managed as follows: (25 Pa. Code § 102.11(c) and 40 CFR § 450.22(e))
- a. Construction dewatering water may not be discharged directly to surface waters.
 - b. The permittee shall use an oil-water separator or suitable filtration device that is designed to remove oil, grease, or other products if dewatering water is found to contain those materials.
 - c. The permittee shall utilize upland vegetated areas of the project site to infiltrate construction dewatering water prior to discharge, to the extent feasible.
 - d. The permittee shall collect and dispose of materials and substances collected by filtration devices and backwash from these devices off-site unless otherwise authorized by DEP/CCD.
4. The permittee shall design, install, implement, and maintain effective pollution prevention measures to minimize the discharge of pollutants. At a minimum, such measures must be designed, installed, implemented and maintained to: (25 Pa. Code § 102.11(c) and 40 CFR § 450.22(f))
- a. Minimize the discharge of pollutants from equipment and vehicle washing, wheel wash water, and other wash waters. Wash waters must be treated in a sediment basin or alternative control that provides equivalent or better treatment prior to discharge.
 - b. Minimize the exposure of building materials, building products, construction wastes, trash, landscape materials, fertilizers, pesticides, herbicides, detergents, sanitary waste and other materials present on the project site to precipitation and to stormwater. Minimization of exposure is not required in cases where the exposure to precipitation and to stormwater will not result in a discharge of pollutants, or where exposure of a specific material or product poses little risk of stormwater contamination (such as final products and materials intended for outdoor use).
 - c. Minimize the discharge of pollutants from spills and leaks and implement chemical spill and leak prevention and response procedures. The permittee shall prepare and implement a Preparedness, Prevention and Contingency (PPC) Plan when storing, using or transporting materials including: fuels, chemicals, solvents, pesticides, fertilizers, lime, petrochemicals, wastewater, wash water, core drilling wastewater, cement, sanitary wastes, solid wastes or hazardous materials onto, on or from the project site during earth disturbance activities. The PPC Plan shall be available upon request by DEP/CCD. (25 Pa. Code § 102.5(l))

5. The permittee may not discharge the following: (25 Pa. Code § 102.11(c) and 40 CFR § 450.22(g))
 - a. Wastewater from washout of concrete.
 - b. Wastewater from washout and cleanout of stucco, paint, form release oils, curing compounds and other construction materials.
 - c. Fuels, oils, or other pollutants used in vehicle and equipment operation and maintenance.
 - d. Soaps or solvents used in vehicle and equipment washing.
6. The permittee shall utilize outlet structures that withdraw water from the surface when discharging from basins and impoundments, unless infeasible. (25 Pa. Code § 102.11(c) and 40 CFR § 450.22(h))

C. Water Quality-Based Effluent Limitations.

Persons proposing or conducting earth disturbance activities shall develop, implement and maintain E&S and PCSM BMPs to minimize the potential for accelerated erosion and sedimentation and to manage post-construction stormwater to ensure that the water quality standards of all affected waters are attained. In addition, earth disturbance activities authorized under this Permit shall achieve wasteload allocations (WLAs) established in any applicable TMDL. All stormwater discharges must comply with all applicable requirements established in accordance with DEP's regulations at 25 Pa. Code Chapters 91-96, 102, and 105. For all permittees covered under this Permit, DEP or CCD may, upon written notice, require additional BMPs or other control measures to ensure that the water quality standards of the receiving waters are attained.

- D. All stormwater discharges must comply with all applicable requirements established in accordance with DEP's regulations at 25 Pa. Code Chapters 91-96, 102, and 105. For all permittees covered under this permit, DEP/CCD may, upon written notice, require additional BMPs or other control measures to ensure that the water quality standards of the receiving waters are attained.
- E. The permittee may not discharge:
 1. Floating solids, scum, sheen or substances that result in observed deposits in the receiving water or foam or substances that produce an observable change in the color, taste, odor or turbidity of the receiving water. (25 Pa. Code § 92a.41(c))
 2. Substances in concentration or amounts sufficient to be inimical or harmful to the water uses to be protected or to human, animal, plant or aquatic life. (25 Pa. Code § 93.6(a))

III. MONITORING, REPORTING AND RECORDKEEPING

- A. When stormwater samples are collected and analyzed or measurements are taken under this permit, the permittee shall assure:
 1. Samples and measurements taken for the purpose of monitoring are representative of the monitored activity. (25 Pa. Code § 92a.3(c) and 40 CFR § 122.41(j)(1))
 2. Records of monitoring information includes: (25 Pa. Code § 92a.3(c) and 40 CFR § 122.41(j)(3))
 - a. The date, exact place, and time of sampling or measurements.
 - b. The individual(s) who performed the sampling or measurements.
 - c. The date(s) analyses were performed.
 - d. The individual(s) who performed the analyses.
 - e. The analytical techniques or methods used.
 - f. The results of such analysis.

3. Monitoring is conducted according to test procedures approved under 40 CFR Part 136 unless another method is required under 40 CFR Subchapters N or O. (25 Pa. Code § 92a.3(c) and 40 CFR § 122.41(j)(4))
4. Sampling and analysis of samples meet proper quality assurance and quality control (QA/QC) procedures. (25 Pa. Code §§ 92a.3(c), 92a.41(a), 92a.61(i) and 40 CFR §§ 122.41(e), 122.41(i)(3), 122.41(i)(4))

B. Records Retention.

1. The permittee shall retain all records of monitoring activities and results, copies of all plans and reports required by this permit, and records of all data used to complete the application for this permit, for at least three (3) years from the date of the Notice of Termination (NOT) approval. The permittee shall submit such records to DEP/CCD upon request. (25 Pa. Code § 92a.3(c) and 122.41(j)(2))
2. The permittee shall retain a physical or electronic copy of this permit, the application submitted for permit issuance, all attachments to the application, and the E&S Plan, PCSM Plan, and PPC Plan, as applicable, on-site during earth disturbance activities at all times, and shall make these documents available to DEP/CCD for inspection upon request.

C. Inspection and Oversight Requirements. (25 Pa. Code § 102.4(b)(5)(x))

1. Site Inspections – The permittee shall conduct visual site inspections throughout the duration of construction and until the NOT has been submitted by the permittee, at the following frequencies:
 - Routine Inspections shall be conducted weekly.
 - Post-Storm Event Inspections shall be conducted within 24 hours after each measurable storm event (0.25 inch or greater) or the occurrence of snowmelt sufficient to cause a discharge.
 - Corrective Action Inspections shall be conducted anytime the permittee observes a deficiency in implementation of the E&S and PCSM Plans.
 - a. The permittee shall document each site inspection on DEP's Chapter 102 Visual Site Inspection Report (3800-FM-BCW0271d) or alternative document or electronic form that collects and retains identical information. All requested information on the Visual Site Inspection Report must be completed. If electronic forms are used to document site inspections, the permittee shall provide a physical copy of the inspection report to DEP/CCD upon request.
 - b. Site inspections shall be performed by personnel that are trained and experienced in E&S and PCSM and are familiar with the E&S and PCSM Plans for the project site.
 - c. To determine if a storm event of 0.25 inch or greater has occurred on a project site, the permittee shall either maintain a rain gauge on-site or obtain storm event information from a weather station that is representative of the project site location.
2. Licensed Professional Oversight of Critical Stages. (25 Pa. Code § 102.8(k))
 - a. A licensed professional or a designee shall be present on-site and be responsible for oversight of critical stages of implementation of the PCSM Plan, unless the permittee meets the requirements of 25 Pa. Code § 102.8(n). Critical stages may include the installation of underground treatment or storage BMPs, structurally engineered BMPs, or other BMPs as deemed appropriate by DEP.
 - b. The licensed professional or designee shall document, using DEP's Chapter 102 Visual Site Inspection Report or another format, findings related to implementation of critical stages of the PCSM Plan. The permittee shall retain this documentation for no less than 3 years from the date of NOT approval and provide it to DEP/CCD upon request.

D. Unanticipated Non-Compliance or Potential Pollution Reporting.

1. Immediate Reporting - The permittee shall immediately report any incident causing or threatening pollution in accordance with the requirements of 25 Pa. Code §§ 91.33 and 92a.41(b) listed below:
 - a. If, because of an accident, other activity or incident a toxic substance or another substance is discharged which would endanger downstream users of the water receiving the discharge, or would otherwise result in pollution or create a danger of pollution or would damage property, the permittee shall immediately notify DEP by telephone of the location and nature of the danger. Oral notification to DEP is required as soon as possible, but no later than four (4) hours after the permittee becomes aware of the incident causing or threatening pollution.
 - b. The permittee shall immediately notify downstream users of the waters of the Commonwealth to which the substance was discharged. Such notice shall include the location and nature of the danger.
 - c. The permittee shall immediately take or cause to be taken steps necessary to prevent injury to property and downstream users of the waters from pollution or a danger of pollution and, in addition, within 15 days from the incident, shall remove the residual substances contained thereon or therein from the ground and from the affected waters of this Commonwealth to the extent required by applicable law.
2. The permittee shall report any non-compliance to DEP/CCD which may endanger health or the environment in accordance with the requirements of 40 CFR § 122.41(l)(6) (as incorporated into 25 Pa. Code § 92a.41). These requirements include the following obligations:
 - a. 24-Hour Reporting - The permittee shall orally report any non-compliance with this permit to DEP/CCD which may endanger health or the environment within 24 hours from the time the permittee becomes aware of the circumstances, including the discovery of soil or other contamination on-site that could result in stormwater pollution.
 - b. Written Report - A written submission shall also be provided to DEP/CCD within 5 days of the time the permittee becomes aware of any non-compliance which may endanger health or the environment. The written submission shall contain a description of the non-compliance and its cause; the period of non-compliance, including exact dates and times, and if the non-compliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the non-compliance.
 - c. Waiver of Written Report – DEP/CCD may waive the written report on a case-by-case basis if the associated oral report has been received within 24 hours from the time the permittee becomes aware of the circumstances which may endanger health or the environment. Unless such a waiver is expressly granted by DEP/CCD, the permittee shall submit a written report in accordance with this paragraph.

3. Other Non-Compliance

The permittee shall identify all instances of non-compliance not reported under paragraph D.2 of this section on the Visual Site Inspection Report. The reports shall contain the information listed in paragraph D.2.b of this section. (25 Pa. Code § 92a.41 and 40 CFR § 122.41(l)(7))

E. Signatory Requirements.

1. Applications, reports and other information submitted to DEP/CCD shall be signed and certified by either of the following applicable persons, in accordance with 40 CFR § 122.22 (as incorporated into 25 Pa. Code § 92a.22):
 - For a corporation - by a president, secretary, treasurer, or vice president in charge of a principal business function of the corporation or a duly authorized representative.

- For a partnership or sole proprietorship - by a general partner or the proprietor, respectively.
 - For a municipality, state, federal or other public agency - by a principal executive officer or ranking elected official.
2. If signed on behalf of a corporation by a duly authorized representative of the permittee, the authorization must meet the following:
- The authorization must be made in writing by a person described in paragraph 1, above, consistent with the corporation's delegation procedures and must be attached to the application or otherwise be submitted to DEP/CCD.
 - The authorization must specify either an individual or a position having responsibility for the operation of the regulated system, facility or activity consistent with the corporation's delegation procedures, such as the position of manager, operator, superintendent, or position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the corporation.
3. Changes in Signatory Authorization - If an authorization is no longer accurate because a different individual or position has responsibility for the overall operation of the system or facility, a new authorization satisfying the requirements of paragraphs 1 and 2, above, must be submitted to DEP/CCD prior to or together with any reports or information to be signed by an authorized representative.
- F. Planned Changes to Physical Facilities – The permittee shall give notice to DEP/CCD as soon as possible but no later than 30 days prior to planned physical alterations or additions to the permitted facility or activity. An application or other written submission to DEP/CCD providing equivalent information can be used to satisfy the notification requirements of this section.

Notice is required when:

1. The alteration or addition to a permitted facility or activity may meet one of the criteria for determining whether a facility or activity is a new source in 40 CFR § 122.29(b). (25 Pa. Code § 92a.41(a) and 40 CFR § 122.41(l)(1)(i))
2. The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. (25 Pa. Code § 92a.41(a) and 40 CFR § 122.41(l)(1)(ii))

For stormwater discharges, this may include:

- a. The construction of additional impervious surfaces not reported in the application.
 - b. Increases in earth disturbance by 10% or more compared, on a cumulative basis, to the original planned limit of disturbance.
 - c. Modifications to the design standards used for the project.
 - d. Proposals to eliminate structural or non-structural BMPs planned for in the original design or reduce the dimensions and/or capacities of structural BMPs that may affect performance of those BMPs.
 - e. Proposed site alterations that would allow new stormwater flows from off-site to flow onto the site.
3. The planned change may result in non-compliance with permit requirements. (25 Pa. Code § 92a.41(a) and 40 CFR § 122.41(l)(2))

G. Monitoring.

DEP may require monitoring of stormwater discharges for Total Suspended Solids (TSS), turbidity or other pollutants when DEP suspects the discharge of pollutants from an earth disturbance activity with coverage under this permit. Upon receipt of written notification from DEP, the permittee shall perform stormwater monitoring. (25 Pa. Code § 92a.61(b))

PART B – STANDARD CONDITIONS

I. MANAGEMENT REQUIREMENTS

A. Compliance.

The permittee shall comply with all conditions of this permit. Any permit non-compliance constitutes a violation of the Act and Clean Streams Law and is grounds for enforcement action, for permit termination, revocation and reissuance, or modification, or denial of a permit renewal application. (25 Pa. Code §§ 92a.3(c), 92a.41(a) and 40 CFR § 122.41(a))

B. Permit Modification, Termination, or Revocation and Reissuance.

1. DEP may modify, terminate or revoke and reissue this permit during its term. (25 Pa. Code §§ 92a.3, 92a.41(a), 92a.72 – 92a.75 and 40 CFR § 122.41(f))
2. The filing of a request by the permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated non-compliance, does not stay any permit condition. (25 Pa. Code §§ 92a.3, 92a.41(a) and 40 CFR § 122.41(f))
3. In the absence of DEP action to modify or revoke and reissue this permit, the permittee shall comply with effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants within the time specified in the regulations that establish those standards or prohibitions. (25 Pa. Code §§ 92a.3(c), 92a.41(a) and 40 CFR § 122.41(a)(1))
4. DEP may terminate coverage under this permit for the reasons specified at 40 CFR § 122.64(a). (25 Pa. Code § 92a.74(c) and 40 CFR § 122.64(a))

C. Duty to Provide Information.

1. The permittee shall furnish to DEP/CCD, within a reasonable time, any information which DEP/CCD may request to determine whether cause exists for modifying, revoking and reissuing, or terminating coverage under this permit, or to determine compliance with this permit. (25 Pa. Code § 92a.41(a) and 40 CFR § 122.41(h))
2. The permittee shall furnish to DEP/CCD, upon request, copies of records required to be kept by this permit. (25 Pa. Code § 92a.41(a) and 40 CFR § 122.41(h))
3. Other Information – Where the permittee becomes aware that it failed to submit any relevant facts in an application, or submitted incorrect information in an application or in any report to DEP/CCD, it shall promptly submit the correct and complete facts or information. (25 Pa. Code § 92a.41(a) and 40 CFR § 122.41(l)(8))

D. Proper Operation and Maintenance.

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances), including BMPs, which are installed or used by the permittee to achieve compliance with the terms and conditions of this permit. The permittee shall properly operate and maintain backup or auxiliary facilities or similar systems installed by the permittee, as necessary to achieve compliance with the terms and conditions of this permit. (25 Pa. Code § 92a.41(a) and 40 CFR § 122.41(e))

E. Duty to Mitigate.

The permittee shall take all reasonable steps to minimize or prevent any discharge in violation of this permit that has a reasonable likelihood of adversely affecting human health or the environment. (25 Pa. Code § 92a.41(a) and 40 CFR § 122.41(d))

II. PENALTIES AND LIABILITY

A. Violations of Permit Conditions.

DEP/CCD may take an enforcement action to restrain violations, to impose criminal or civil penalties, to withhold a permit, or to seek other remedies or relief as authorized by the Clean Streams Law against a permittee that violates any condition or limitation of this permit, or any rule, regulation or order issued by DEP/CCD.

B. Falsifying Information.

The permittee or any person who engages in the conduct described below may, upon conviction, be punished by a fine and/or imprisonment pursuant to 18 Pa.C.S. § 4904, or 40 CFR §§ 122.41(j)(5) or (k)(2). (25 Pa. Code § 92a.41(a))

- Falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit; or
- Knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit (including monitoring reports or reports of compliance or non-compliance).

C. Liability.

Nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for non-compliance pursuant to Section 309 of the Clean Water Act or Sections 602, 603 or 605 of the Clean Streams Law.

Nothing in this permit shall be construed to preclude the institution of any legal action or to relieve the permittee from any responsibilities, liabilities or penalties to which the permittee is or may be subject to under the Clean Water Act and the Clean Streams Law.

D. Need to Halt or Reduce Activity Not a Defense.

The permittee may not maintain as a defense in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit. (25 Pa. Code § 92a.41(a) and 40 CFR § 122.41(c))

III. OTHER RESPONSIBILITIES

A. Right of Entry.

The permittee shall allow authorized representatives of DEP/CCD and EPA to conduct the following activities upon the presentation of credentials and other documents as may be required by law (35 P.S. §§ 691.5(b) and 691.305, 25 Pa. Code § 92a.41(a) and 40 CFR § 122.41(i)(2)):

1. To enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit; (40 CFR § 122.41(i)(1))
2. To have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit; (40 CFR § 122.41(i)(2))
3. To inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices or operations regulated or required under this permit; and (40 CFR § 122.41(i)(3))
4. To sample or monitor at reasonable times, for the purposes of assuring permit compliance or as otherwise authorized by the Clean Water Act or the Clean Streams Law, any substances or parameters at any location. (40 CFR § 122.41(i)(4))

B. Transferring Permit Coverage.

1. Transfer Requests by Permittees. (25 Pa. Code § 92a.71 and 40 CFR § 122.61(b))

- a. If the permittee (i.e., the person(s) identified on the application form as the applicant(s)) decides to transfer the permit to another person(s) prior to submission of an NOT to terminate coverage, the permittee shall submit an application to DEP/CCD to transfer permit coverage at least 30 days prior to the proposed date of transfer, using DEP's Application for NPDES or WQM Permit Transfer (3800-PM-BCW0041) (Transfer Application). The permit will be automatically transferred to the new permittee on the date specified in the Transfer Application if all of the following are true:
 - i. The Transfer Application is signed by the existing and new permittees and contains a specific date for transfer of permit responsibility, coverage and liability between them.
 - ii. DEP does not notify the existing permittee and the proposed new permittee in writing prior to the transfer date of its intent to modify or revoke and reissue this permit.
 - iii. The new permittee is in compliance with existing DEP/CCD issued permits, regulations, orders and schedules of compliance, or has demonstrated that any non-compliance with the existing permits has been resolved by an appropriate compliance action or by the terms and conditions of the permit (including compliance schedules set forth in the permit), consistent with 25 Pa. Code § 92a.51 (relating to schedules of compliance) and other appropriate DEP regulations.
- b. If the transfer does not occur automatically as specified in paragraph B.1.a of this section, the permit may be transferred by the permittee to a new owner or operator only if both parties request a modification of the permit, using the Transfer Application, and DEP/CCD approves the modification or revokes and reissues the permit. The permit may be transferred both during the term of this permit and during period(s) of administrative extension of this permit.
- c. In the event DEP/CCD does not approve transfer of this permit, the new owner or operator must submit a new application.
- d. Transfer of a portion of a project site is not authorized under this permit unless otherwise approved by DEP.
- e. The Transfer Application must include information required by Part C VI of this permit, relating to long-term operation and maintenance of PCSM BMPs, where applicable.

2. Co-Permittee Requirements for Operators. (25 Pa. Code § 102.5(h))

- a. Operators who are not the permittee shall be co-permittees. Following approval of coverage, the permittee shall require any operator, as defined in this permit, that was not identified on the application for permit coverage to complete and sign the Co-Permittee Acknowledgement for Chapter 102 Permits form (3800-FM-BCW0271a) prior to commencing earth disturbance activities covered by this permit. The permittee shall complete and sign the Co-Permittee Acknowledgement form, retain the form for a period no less than three (3) years, and submit the form to DEP/CCD prior to the operator engaging in earth disturbance activities. Upon signing the Co-Permittee Acknowledgement form, the operator is considered a co-permittee.
- b. If an operator completes its job responsibilities, the operator may elect to terminate its responsibilities under the permit, prior to submission of an NOT by the permittee, by completing and signing a Co-Permittee Liability Release form (3800-FM-BCW0271). These forms shall be signed by the permittee, retained by the permittee for a period no less than three (3) years, and submitted to DEP/CCD.

C. Amending Permit Coverage.

The permittee shall notify DEP/CCD of any planned change to earth disturbance activities, BMPs, or any other change that may affect permit coverage prior to implementing the change. DEP/CCD will notify the permittee whether the submission of an application to amend permit coverage is required. The permittee may not proceed to implement the proposed change until the permittee receives written approval for the amendment from DEP/CCD, when applicable.

D. Terminating Permit Coverage.

1. General.

Upon permanent stabilization of earth disturbance activities under 25 Pa. Code § 102.22(a)(2) and installation of BMPs in accordance with the E&S Plan and, where applicable, the PCSM Plan, the permittee shall submit a Notice of Termination (NOT) to DEP/CCD using form 3800-PM-BCW0229b. A copy of the NOT must be submitted to the municipality(ies) where the project site is located. The NOT must include:

- a. The project site name, address, and location.
- b. The operator name and address.
- c. The permit number.
- d. The reason for the permit termination.
- e. Information required by Part C VI of this permit, relating to long-term operation and maintenance of PCSM BMPs, where applicable.

2. Responsibility.

Until the permittee has received written approval of the NOT, the permittee, and co-permittees, will remain responsible for compliance with the permit terms and conditions, including long-term operation and maintenance of all PCSM BMPs on the project site and is responsible for violations occurring on the project site. DEP/CCD will conduct an inspection and approve or deny the NOT within 30 days of receipt. (25 Pa. Code § 102.7(c))

3. PCSM BMP Final Certification.

- a. The permittee shall enclose with the NOT "Record Drawings" with a final certification statement from a licensed professional, which reads as follows:

"I (name) do hereby certify pursuant to the penalties of 18 Pa. C.S.A. § 4904 to the best of my knowledge, information, and belief, that the accompanying record drawings accurately reflect the as built conditions, are true and correct, and are in conformance with Chapter 102 of the rules and regulations of the Department of Environmental Protection and that the project site was constructed in accordance with the approved PCSM Plan, all approved plan changes, and accepted construction practices."

- b. The permittee shall retain a copy of the record drawings as part of the approved PCSM Plan. The permittee shall also provide a copy of the record drawings as part of the approved PCSM Plan to the following: 1) the persons identified as responsible for the long-term operation and maintenance of PCSM BMPs; 2) DEP/CCD; and 3) the municipality(ies) where the project is located. (25 Pa. Code § 102.8(l))

E. Property Rights.

The approval of coverage under this permit does not convey any property rights, or any exclusive privilege. (25 Pa. Code § 92a.41(a) and 40 CFR 122.41(g))

F. Duty to Reapply.

If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee must apply for and obtain a new permit. (25 Pa. Code §§ 92a.3(c), 92a.41(a)(2) and 40 CFR § 122.41(b))

G. Incorporation of Application.

The approval of coverage is granted based, in part, on information provided by the applicant in the application. The information provided by the applicant, including all attachments, plans and supporting documentation, are incorporated by reference as part of the approval and are enforceable as a condition of the approval. If there is any conflict between the permit and the application, including any attachments, plans, and other supporting documentation, the more protective provision applies.

H. Other Laws.

No condition of this permit releases the permittee from any responsibility, requirement, or liability under other federal or Pennsylvania statutes or regulations or any local ordinance.

PART C – SPECIAL CONDITIONS

I. AUTHORIZED DISCHARGES

A. Authorized Stormwater Discharges.

The following stormwater discharges associated with construction activity are authorized under the permit provided that the appropriate stormwater controls are designed, installed, and maintained by the permittee in accordance with applicable laws, regulations and guidance administered by DEP or EPA:

1. Stormwater discharges, including stormwater runoff, snowmelt runoff, and surface runoff and drainage, associated with construction activity as defined at 40 CFR § 122.26(b)(14)(x).
2. Stormwater discharges designated by DEP as needing permit coverage under 40 CFR § 122.26(a)(1)(v), 40 CFR § 122.26(b)(15)(ii) or the Pennsylvania Clean Streams Law that are associated with construction activity resulting in an earth disturbance of less than five acres.
3. Stormwater discharges from off-site construction support activities (off-site support activities) including but not limited to concrete or asphalt batch plants, equipment staging yards, material storage areas, excavated material disposal (spoil) areas, borrow areas, stockpiling of topsoil, transfer of topsoil to other locations, and turnaround areas, provided that:
 - a. The off-site support activity is part of the same common plan of development or sale required to have permit coverage for stormwater discharges.
 - b. The area of the off-site support activity, in combination with the project site it supports (i.e., the same common plan of development or sale), involves less than five acres of earth disturbance in total.
 - c. The off-site support activity is not a commercial operation, nor does it serve multiple unrelated construction sites.
 - d. The off-site support activity does not continue to operate beyond the completion of the construction activity at the project site it supports and will be restored to approximate original condition, as defined in the permit.

B. Authorized Non-Stormwater Discharges.

The following non-stormwater discharges associated with construction activity are authorized under the permit provided that, with the exception of water used to control dust and to irrigate vegetation in stabilized areas, these discharges are not routed to areas of exposed soil on the project site and the operator complies with any applicable requirements for these discharges under the permit:

1. Discharges from emergency fire-fighting activities.
2. Fire hydrant and waterline flushings that do not contain measurable concentrations of Total Residual Chlorine (TRC).
3. Landscape irrigation water.
4. Water used to wash vehicles and equipment where cleaning agents are not used.
5. Water used to control dust.
6. External building washdown where cleaning agents are not used and external surfaces do not contain hazardous substances.
7. Pavement wash waters, provided spills or leaks of toxic or hazardous substances have not occurred and where cleaning agents are not used if such wash waters are directed to a sediment basin or similar BMP.

8. Uncontaminated air conditioning or compressor condensate.
9. Uncontaminated, non-turbid discharges of groundwater or spring water.
10. Foundation or footing drainage where flows are not contaminated with process materials such as solvents or contain pollutants from groundwater.
11. Construction dewatering water that complies with the construction dewatering discharge requirements of the permit.

II. COMMENCEMENT OF DISCHARGES

No new discharge may be commenced under this permit until the applicant demonstrates compliance with and/or completes all of the following:

- A. A complete application package (3800-PM-BCW0407b and required attachments) has been submitted, as determined by DEP/CCD, in accordance with the requirements of the permit and permit instructions.
- B. The applicant has received the written permit, signed by the appropriate DEP manager.
- C. The applicant has obtained all other state and local permits and approvals arising out of the earth disturbance activities reported in the application, including but not limited to sewage planning approval required by the Pennsylvania Sewage Facilities Act (Act 537), if applicable.
- D. A pre-construction meeting has been held unless waived by DEP/CCD, in writing.

III. PRE-CONSTRUCTION MEETING AND NOTIFICATION

- A. A pre-construction meeting is required unless the permittee has been notified otherwise in writing by DEP/CCD. The permittee shall invite the agency approving coverage under this permit to attend the pre-construction meeting and provide at least 7 days' notice of the pre-construction meeting to all invited attendees. Permittees, co-permittees, operators, and licensed professionals or designees responsible for the earth disturbance activity, including implementation of E&S and PCSM Plans and critical stages of implementation of the approved PCSM Plan, shall attend a pre-construction meeting. (25 Pa. Code § 102.5(e))
- B. The permittee shall provide written or verbal notification to DEP/CCD upon completing the installation or stabilization of all perimeter sediment control BMPs and at least three (3) days prior to proceeding with the bulk earth disturbance activities.

IV. E&S PLANS

- A. The permittee shall implement an E&S Plan that meets the requirements of 25 Pa. Code § 102.4(b) and contains E&S BMPs that will be designed, implemented and maintained to minimize the potential for accelerated erosion and sedimentation and achieve the effluent limitations set forth in Part A of this permit.
- B. The E&S Plan, including construction sequencing and operation and maintenance of BMPs, shall be implemented at all times.
- C. The permittee shall maintain the approved E&S Plan on-site during earth disturbance activities at all times and shall make the plan available for inspection by DEP/CCD upon request.

V. PCSM PLANS

- A. The permittee shall implement a PCSM Plan that meets the requirements of 25 Pa. Code § 102.8 and contains PCSM BMPs that will be designed, implemented and maintained to achieve the effluent limitations set forth in Part A of this permit.

- B. The PCSM Plan, including construction sequencing and operation and maintenance of BMPs, shall be implemented at all times.
- C. The permittee shall maintain the authorized PCSM Plan on-site during earth disturbance activities at all times and shall make the plan available for inspection by DEP/CCD upon request.

VI. LONG-TERM OPERATION AND MAINTENANCE OF PCSM BMPs

- A. The permittee shall be responsible for long-term operation and maintenance (O&M) of PCSM BMPs unless a different person is identified in the NOT and that person has agreed to long-term O&M of PCSM BMPs. (25 Pa. Code § 102.8(m)(1))
- B. For any property containing PCSM BMPs, the permittee shall record an instrument with the Recorder of Deeds which will assure disclosure of the PCSM BMPs and the related obligations in the ordinary course of a title search of the subject property within 45 days of approval of coverage under this Permit, unless extended in writing by DEP or CCD. The recorded instrument must:
 - 1. Identify the PCSM BMPs. PCSM BMPs under this Permit include all BMPs identified in the PAG-01 NOI and PCSM Plan, including vegetated areas used for managing stormwater through overland flow.
 - 2. Provide for necessary access related to long-term O&M for PCSM BMPs.
 - 3. Provide notice that the responsibility for long-term O&M of the PCSM BMPs is a covenant that runs with the land that is binding upon and enforceable by subsequent grantees.

The permittee shall provide proof of filing the instrument with the Recorder of Deeds as an attachment to the Transfer Application required by Part B III.B of this Permit, if applicable, and the NOT required by Part B III.D of this Permit. (25 Pa. Code § 102.8(m)(2))

- C. For Commonwealth-owned or federally-owned property, a covenant that runs with the land is not required until the transfer of the land containing a PCSM BMP to a non-Commonwealth or non-federal entity occurs. Upon transfer of the Commonwealth-owned or federally-owned property containing the PCSM BMP, the deed must comply with 25 Pa. Code § 102.8(m). (25 Pa. Code § 102.8(m)(3))
- D. The person responsible for performing long-term O&M may enter into a written agreement with another person, including a CCD, nonprofit organization, municipality, authority, private corporation, or other person, to transfer the responsibility for PCSM BMPs or to perform long-term O&M and provide notice thereof to DEP/CCD. (25 Pa. Code § 102.8(m)(4))
- E. A permittee that fails to transfer long-term O&M of the PCSM BMPs or otherwise fails to comply with this requirement, shall remain jointly and severally responsible with the landowner for long-term O&M of the PCSM BMPs located on the property. (25 Pa. Code § 102.8(m)(5))
- F. The permittee shall include record drawings that accurately reflect as-built conditions and contain a long-term O&M schedule as an attachment to the recorded instrument, either directly or by reference. The long-term O&M schedule must provide for access to the PCSM BMPs in addition to information on inspection, repair, replacement, and routine maintenance to ensure proper function and operation of the PCSM BMPs.
- G. For PCSM BMPs that are located within urbanized areas or otherwise discharge to a municipal separate storm sewer system (MS4), the permittee shall specify in the long-term O&M schedule that copies of all inspection reports be submitted by the person responsible for long-term O&M to the municipality or other entity that owns or operates the MS4.
- H. Unless an alternative process is approved by DEP/CCD in writing, upon the sale or other transfer of any parcel, lot, road or other real property included within the permit boundary, the permittee shall notify the purchaser, grantee, or transferee of the long-term PCSM BMP O&M requirements. The permittee shall expressly identify:
 - 1. The PCSM BMPs on each property.

2. The schedule for inspection and reporting.
3. The person or entity responsible for long-term O&M of the PCSM BMPs.
4. How access to the BMPs will be achieved.

Unless a later date is approved by DEP in writing, the permittee shall provide DEP and CCD with notice of compliance with this section within 45 days from the date of transfer of the property and at the time the permittee files an NOT.

VII. CLEAN FILL AND SITE CONTAMINATION

- A. With the exception of sites enrolled in DEP's Land Recycling and Environmental Remediation Standards (Act 2) program and sites with DEP Waste Management General Permit (WMGR096) approval to use regulated fill, all fill material imported to the site must meet the definition of clean fill, as defined in this permit. Regulated fill may only be used on Act 2 sites, in accordance with standards established by that program, and on sites with DEP General Permit WMGR096 approval.
- B. The permittee shall conduct environmental due diligence to verify that soils excavated on-site that is used to establish final grade and fill imported to the project site is considered clean fill. If due diligence results in evidence of a release, as defined in DEP's Management of Fill Policy (285-2182-773), that has affected the fill material, the permittee shall test the material to determine whether the material qualifies as clean fill, and DEP's electronic Form FP-001 (Certification of Clean Fill) must be completed, retained by the permittee or the property owner on-site, and be made available to DEP/CCD upon request.
- C. If the permittee becomes aware during earth disturbance activities that soils in the area of earth disturbance contain concentrations of regulated substances exceeding the residential medium-specific concentrations for soil in 25 Pa. Code Chapter 250, that were not previously disclosed to DEP/CCD, the permittee shall notify DEP/CCD in accordance with Part A III.D of this permit and cease earth disturbance activities in areas of known soil contamination until authorized to resume by DEP/CCD.
- D. If the permittee encounters groundwater during excavation that the permittee knows or has reason to believe is contaminated by one or more pollutants at concentrations exceeding water quality criteria contained in 25 Pa. Code Chapter 93, that were not previously disclosed to DEP/CCD, the permittee shall notify DEP/CCD in accordance with Part A III.D of this permit. Contaminated groundwater may not be pumped or otherwise diverted to surface waters unless specifically authorized by DEP/CCD.

VIII. IMPLEMENTATION OF PERMIT REQUIREMENTS

- A. Prior to commencement of construction activities or commencement of work on the project site, the permittee and co-permittees shall ensure that the following personnel understand the requirements of and their specific responsibilities under this permit:
 1. Personnel responsible for the installation, maintenance, and/or repair of E&S and PCSM BMPs and implementation of the PPC Plan.
 2. Personnel responsible for the application and storage of treatment chemicals (if applicable).
 3. Personnel responsible for conducting inspections.
 4. Personnel responsible for taking corrective actions.
- B. The permittee and co-permittee(s) are responsible for ensuring that all activities on the project site comply with the requirements of this permit. The permittee and co-permittee(s) are not required to provide or document formal training for subcontractors or other outside service providers, but the permittee and co-permittee(s) must ensure that personnel understand any requirements of this permit that are relevant to the work they are subcontracted to perform.

- C. At a minimum, the permittee and co-permittee(s) must ensure that personnel understand the following if related to the scope of their job duties (e.g., only personnel responsible for conducting inspections need to understand how to conduct inspections).
 - 1. When and how to conduct site inspections, record applicable findings, and take correction actions.
 - 2. The permit deadlines associated with installation, maintenance, removal of stormwater controls, and site stabilization.
 - 3. The location of all stormwater controls on the project site required by this permit and how they are to be maintained.
 - 4. The proper procedures to follow with respect to the permit's pollution prevention requirements and when to notify DEP/CCD of potential pollution and changes to earth disturbance activities.
- D. A training log must be kept on-site and made available upon request from EPA, DEP, or CCD staff.
- E. All personnel must have access at all times during earth disturbance activities to an electronic or paper copy of this permit, the approved copies of the E&S, PCSM and PPC Plans, and other relevant documents or information that must be kept with these plans.

IX. OTHER REQUIREMENTS

A. Cessation of Earth Disturbance Activities.

The permittee shall cease earth disturbance activities resulting in stormwater discharges during construction upon written notification from DEP/CCD in the form of an order or inspection report, and may not resume such activities until authorized to do so by DEP/CCD. DEP/CCD may require cessation of earth disturbance activities where required plans are not in place, where plans are significantly deficient and could result in environmental harm, or where potential or actual harm is identified during on-site inspections.

B. Compliance and Enforcement.

- 1. A person aggrieved by an action of a CCD shall request an informal hearing with DEP within 30 days following the notice of the action. DEP will schedule the informal hearing and make a final determination within 30 days of the request. Any final determination by DEP under the informal hearing may be appealed to the Environmental Hearing Board (EHB) in accordance with established administrative and judicial procedures. (25 Pa. Code § 102.32(c))
- 2. For enforcement action taken under this permit, DEP/CCD may collect or recover, from the responsible party, costs and expenses involved in taking enforcement action and initiating cost recovery actions. DEP/CCD may collect the amount in the same manner as civil penalties are collected under section 605 of The Clean Streams Law (35 P.S. § 691.605). (25 Pa. Code § 102.32(d))

C. Waste Management.

The permittee shall handle, recycle and/or dispose of collected screenings, slurries, sludges, and other solids in compliance with state and federal law, including the Solid Waste Management Act (35 P.S. §§ 6018.101 – 6018.1003), 25 Pa. Code Chapters 287, 288, 289, 291, 295, 297, and 299 (relating to requirements for landfilling, impoundments, land application, composting, processing, and storage of residual waste), Chapters 261a, 262a, 263a, and 270a (related to identification of hazardous waste, requirements for generators and transporters, and hazardous waste, requirements for generators and transporters, and hazardous waste permit programs), 40 CFR Part 257 (relating to criteria for classification of solid waste disposal facilities and practices), The Clean Streams Law, and the Clean Water Act.

D. Non-Stormwater Discharges.

Except as set forth in Part C I.B of this permit, non-stormwater discharges are not authorized under this permit. The permittee shall cease any non-stormwater discharge upon receipt of written notification from DEP/CCD that the discharge is not authorized under the permit.

E. Off-Site Support Activities.

The permittee may utilize only those off-site support activities meeting the following criteria:

1. The off-site support activities have been identified in the application.
2. If the off-site support activities have not been identified in the application, the permittee has notified DEP/CCD of the identification of the off-site support activities, and DEP/CCD has approved a minor amendment of the permittee's coverage under this permit.
3. A written E&S Plan has been developed for the off-site support activities if earth disturbance is greater than or equal to 5,000 square feet, and E&S BMPs are implemented and maintained. The permittee shall submit a copy of the E&S Plan, if applicable, to DEP/CCD upon request.

F. Discharges to Non-Surface Waters.

The permittee shall ensure that E&S and PCSM BMPs are installed and maintained for all discharges to non-surface waters, including but not limited to swales, ditches, and the ground surface.

G. Corrective Action.

1. The permittee shall identify all deficiencies in E&S or PCSM Plan implementation on Visual Site Inspection Reports and document the corrective action that will be taken to mitigate the deficiency.
2. The permittee shall implement corrective action immediately upon becoming aware of any deficiency that results in an incident causing or threatening pollution to waters of the Commonwealth, and shall notify DEP in accordance with Part A III.D.1 of this permit. For all other deficiencies, the permittee shall implement corrective action as soon as possible but no later than seven (7) days following identification of the deficiency, unless otherwise approved by DEP/CCD.

H. Archaeological Specimens.

The permittee and its agents shall visually inspect for archaeological specimens, as the term is defined in the Pennsylvania State History Code (37 Pa. C.S.A., Section 101 *et seq.*), during earth disturbance activities, and shall immediately cease earth disturbance activities upon discovery of archaeological specimens. Upon discovery the permittee shall immediately notify DEP/CCD and the Pennsylvania Historical and Museum Commission (PHMC) (Phone: (717) 783-8947).

I. Threatened and Endangered Species Protection.

1. If applicable, the permittee shall comply with the provisions of any Habitat Conservation Plan approved by the jurisdictional resource agencies to protect State or Federal threatened and endangered species.
2. If any potential impact to federal or state threatened or endangered species is identified on the Pennsylvania Natural Diversity Inventory (PNDI) receipt, the permittee shall implement any avoidance/mitigation measures indicated on the PNDI receipt and/or other measures determined necessary by the resource agencies in a clearance letter, determination or other correspondence to resolve potential species impacts and ensure compliance with applicable federal and State laws pertaining to the protection of Federal or state threatened and endangered species.
3. When conducting earth disturbance activities, the permittee has a continuing obligation to ensure compliance with applicable federal and state laws pertaining to the protection of federal or state threatened and endangered species.

J. Wetland Protection.

If hydric soils or other wetland features are present on the project site, the permittee shall conduct a wetland determination in accordance with DEP procedures. A copy of that wetland determination must be provided to DEP/CCD as an attachment to the application, and all wetlands must be identified on the E&S Plan and PCSM Plan. Special precautions must be taken to protect wetlands and other water resources identified in the application, plans, and other supporting documents during earth disturbance activities.

K. Infiltration BMPs.

Where infiltration BMPs are being utilized, the permittee and co-permittee must ensure that soil compaction is avoided or minimized in those areas. If the areas planned for infiltration BMPs are compromised through compaction or other means, additional soil testing must be performed to verify that the BMP will perform as planned.

L. Antidegradation Requirements.

The permittee shall implement a non-discharge alternative and/or the ABACT E&S and PCSM BMPs identified in Antidegradation Analysis Module 3 (3800-PM-BCW0406c) and the approved E&S and PCSM Plans to satisfy antidegradation implementation requirements of 25 Pa. Code §§ 93.4c, 102.4(b)(6) and 102.8(h).

M. Riparian Buffer Implementation Requirements.

1. The permittee shall maintain an existing riparian buffer or riparian forest buffer, convert a riparian buffer to a riparian forest buffer or establish a new riparian buffer or riparian forest buffer (either on the project site or at a separate off-site location within the same drainage list as the project site) in accordance with Riparian Buffer Module 4 (3800-PM-BCW0406d) and the approved PCSM Plan to satisfy riparian buffer requirements of 25 Pa. Code § 102.14 or Section 402(c) of Pennsylvania's Clean Streams Law.
2. An existing, converted or newly established riparian forest buffer must meet the requirements set forth in 25 Pa. Code § 102.14(b).
3. The permittee shall comply with the mandatory requirements for all riparian buffers at 25 Pa. Code § 102.14(c).
4. The permittee shall provide for permanent protection of riparian buffers in accordance with 25 Pa. Code § 102.14(g).
5. The permittee shall submit DEP Form ID 3000-FM-OWP0100, PA Stream Buffer Tracking form, or equivalent, to DEP/CCD within one year of establishment or protection of the riparian buffer.

1. PROJECT INFORMATION

Project Name: **Hickory Run State Park Latrine Improvements**

Date of Review: **11/2/2022 10:00:42 AM**

Project Category: **Development, New public/community development (school, library, church, museum)**

Project Area: **67.92 acres**

County(s): **Carbon**

Township/Municipality(s): **KIDDER TOWNSHIP**

ZIP Code:

Quadrangle Name(s): **HICKORY RUN**

Watersheds HUC 8: **Lehigh**

Watersheds HUC 12: **Black Creek-East Side of Lehigh River; Stony Creek-Lehigh River**

Decimal Degrees: **41.021310, -75.680662**

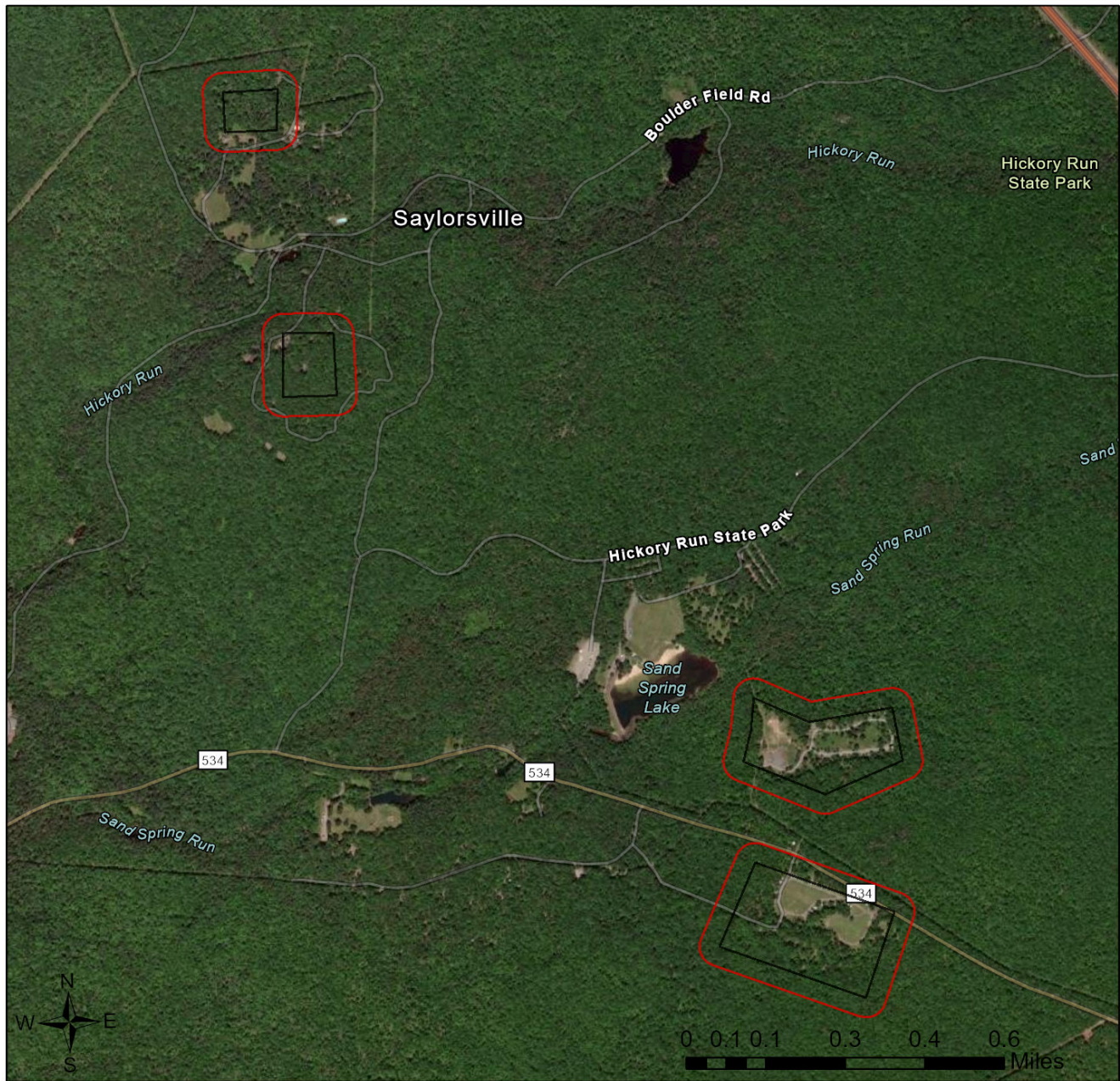
Degrees Minutes Seconds: **41° 1' 16.7172" N, 75° 40' 50.3822" W**



2. SEARCH RESULTS

Agency	Results	Response
PA Game Commission	No Known Impact	No Further Review Required
PA Department of Conservation and Natural Resources	Potential Impact	FURTHER REVIEW IS REQUIRED, See Agency Response
PA Fish and Boat Commission	Potential Impact	FURTHER REVIEW IS REQUIRED, See Agency Response
U.S. Fish and Wildlife Service	No Known Impact	No Further Review Required

As summarized above, Pennsylvania Natural Diversity Inventory (PNDI) records indicate there may be potential impacts to threatened and endangered and/or special concern species and resources within the project area. If the response above indicates "No Further Review Required" no additional communication with the respective agency is required. If the response is "Further Review Required" or "See Agency Response," refer to the appropriate agency comments below. Please see the DEP Information Section of this receipt if a PA Department of Environmental Protection Permit is required.

Hickory Run State Park Latrine Improvements

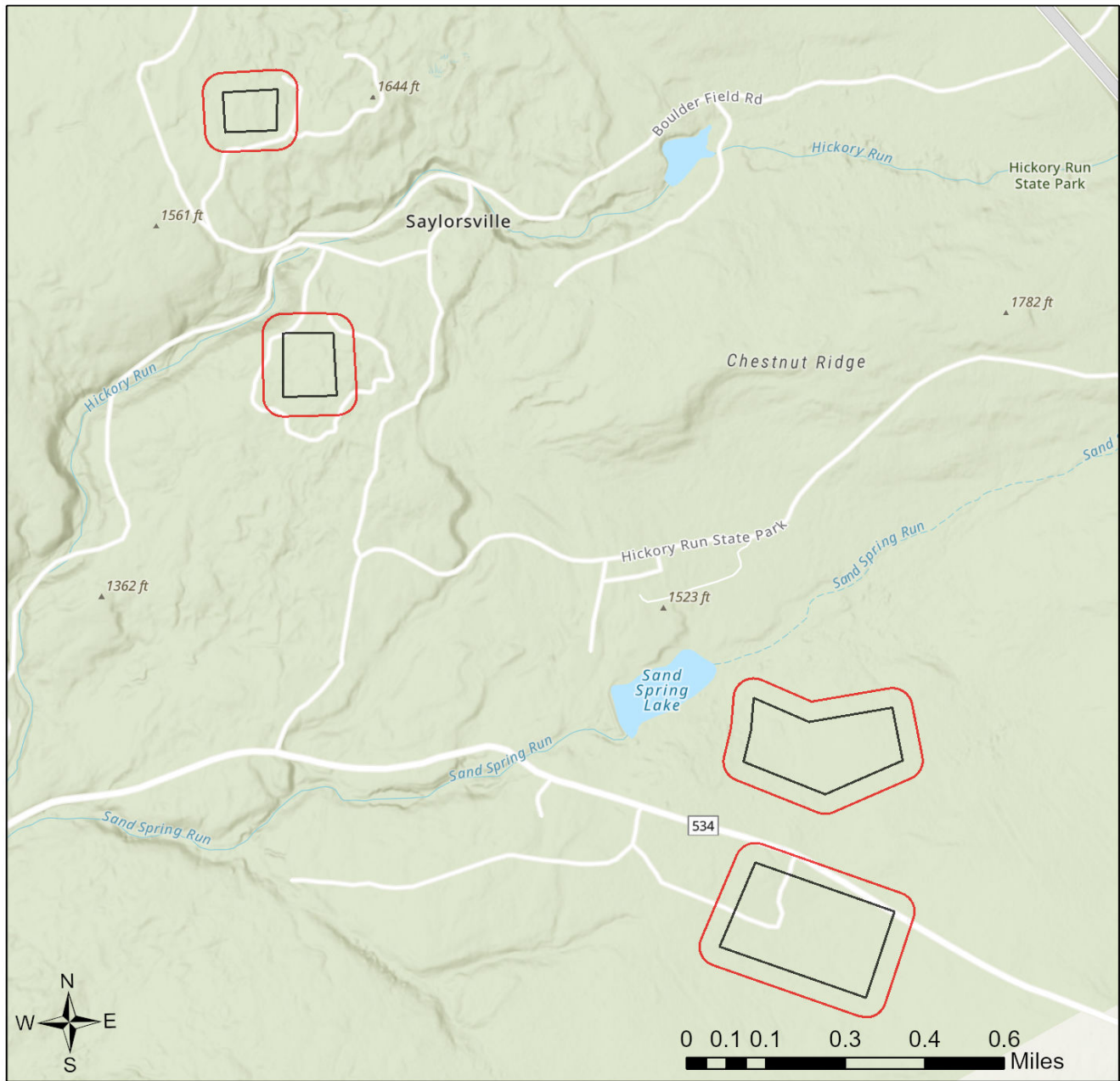




-  Buffered Project Boundary
-  Project Boundary



Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community

Hickory Run State Park Latrine Improvements



-  Buffered Project Boundary
-  Project Boundary



Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community

RESPONSE TO QUESTION(S) ASKED

Q1: Will the entire project occur within an existing building, parking lot, driveway, road, street, or maintained (periodically mowed) lawn?

Your answer is: No

Q2: The proposed project is in the range of the Indiana bat. Describe how the project will affect bat habitat (forests, woodlots and trees) and indicate what measures will be taken in consideration of this. Round acreages up to the nearest acre (e.g., 0.2 acres = 1 acre).

Your answer is: The project will affect 1 to 39 acres of forests, woodlots and trees.

Q3: Is tree removal, tree cutting or forest clearing of 40 acres or more necessary to implement all aspects of this project?

Your answer is: No

3. AGENCY COMMENTS

Regardless of whether a DEP permit is necessary for this proposed project, any potential impacts to threatened and endangered species and/or special concern species and resources must be resolved with the appropriate jurisdictional agency. In some cases, a permit or authorization from the jurisdictional agency may be needed if adverse impacts to these species and habitats cannot be avoided.

These agency determinations and responses are **valid for two years** (from the date of the review), and are based on the project information that was provided, including the exact project location; the project type, description, and features; and any responses to questions that were generated during this search. If any of the following change: 1) project location, 2) project size or configuration, 3) project type, or 4) responses to the questions that were asked during the online review, the results of this review are not valid, and the review must be searched again via the PNDI Environmental Review Tool and resubmitted to the jurisdictional agencies. The PNDI tool is a primary screening tool, and a desktop review may reveal more or fewer impacts than what is listed on this PNDI receipt. The jurisdictional agencies **strongly advise against** conducting surveys for the species listed on the receipt prior to consultation with the agencies.

PA Game Commission

RESPONSE:

No Impact is anticipated to threatened and endangered species and/or special concern species and resources.

PA Department of Conservation and Natural Resources

RESPONSE:

Further review of this project is necessary to resolve the potential impact(s). Please send project information to this agency for review (see WHAT TO SEND).

DCNR Species: (Note: The Pennsylvania Conservation Explorer tool is a primary screening tool, and a desktop review may reveal more or fewer species than what is listed below. After desktop review, if a botanical survey is required by DCNR, we recommend the DCNR Botanical Survey Protocols, available here:

<https://conservationexplorer.dcnr.pa.gov/content/survey-protocols>)

Scientific Name	Common Name	Current Status	Proposed Status	Survey Window
Papaipema sp. 1	Flypoison Borer Moth	Special Concern Species*	Special Concern Species*	

PA Fish and Boat Commission

RESPONSE:

Further review of this project is necessary to resolve the potential impact(s). Please send project information to this agency for review (see WHAT TO SEND).

PFBC Species: (Note: The Pennsylvania Conservation Explorer tool is a primary screening tool, and a desktop review may reveal more or fewer species than what is listed below.)

Scientific Name	Common Name	Current Status
Sensitive Species**		Endangered

U.S. Fish and Wildlife Service

RESPONSE:

No impacts to **federally** listed or proposed species are anticipated. Therefore, no further consultation/coordination under the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq. is required. Because no take of federally listed species is anticipated, none is authorized. This response does not reflect potential Fish and Wildlife Service concerns under the Fish and Wildlife Coordination Act or other authorities.

* Special Concern Species or Resource - Plant or animal species classified as rare, tentatively undetermined or candidate as well as other taxa of conservation concern, significant natural communities, special concern populations (plants or animals) and unique geologic features.

** Sensitive Species - Species identified by the jurisdictional agency as collectible, having economic value, or being susceptible to decline as a result of visitation.

WHAT TO SEND TO JURISDICTIONAL AGENCIES

If project information was requested by one or more of the agencies above, upload* or email the following information to the agency(s) (see AGENCY CONTACT INFORMATION). Instructions for uploading project materials can be found [here](#). This option provides the applicant with the convenience of sending project materials to a single location accessible to all three state agencies (but not USFWS).

*If information was requested by USFWS, applicants must email, or mail, project information to IR1_ESPenn@fws.gov to initiate a review. USFWS will not accept uploaded project materials.

Check-list of Minimum Materials to be submitted:

Project narrative with a description of the overall project, the work to be performed, current physical characteristics of the site and acreage to be impacted.

A map with the project boundary and/or a basic site plan (particularly showing the relationship of the project to the physical features such as wetlands, streams, ponds, rock outcrops, etc.)

In addition to the materials listed above, USFWS REQUIRES the following

SIGNED copy of a Final Project Environmental Review Receipt

The inclusion of the following information may expedite the review process.

___ Color photos keyed to the basic site plan (i.e. showing on the site plan where and in what direction each photo was taken and the date of the photos)

___ Information about the presence and location of wetlands in the project area, and how this was determined (e.g., by a qualified wetlands biologist), if wetlands are present in the project area, provide project plans showing the location of all project features, as well as wetlands and streams.

4. DEP INFORMATION

The Pa Department of Environmental Protection (DEP) requires that a signed copy of this receipt, along with any required documentation from jurisdictional agencies concerning resolution of potential impacts, be submitted with applications for permits requiring PNDI review. Two review options are available to permit applicants for handling PNDI coordination in conjunction with DEP's permit review process involving either T&E Species or species of special concern. Under sequential review, the permit applicant performs a PNDI screening and completes all coordination with the appropriate jurisdictional agencies prior to submitting the permit application. The applicant will include with its application, both a PNDI receipt and/or a clearance letter from the jurisdictional agency if the PNDI Receipt shows a Potential Impact to a species or the applicant chooses to obtain letters directly from the jurisdictional agencies. Under concurrent review, DEP, where feasible, will allow technical review of the permit to occur concurrently with the T&E species consultation with the jurisdictional agency. The applicant must still supply a copy of the PNDI Receipt with its permit application. The PNDI Receipt should also be submitted to the appropriate agency according to directions on the PNDI Receipt. The applicant and the jurisdictional agency will work together to resolve the potential impact(s). See the DEP PNDI policy at <https://conservationexplorer.dcnr.pa.gov/content/resources>.



5. ADDITIONAL INFORMATION

The PNDI environmental review website is a preliminary screening tool. There are often delays in updating species status classifications. Because the proposed status represents the best available information regarding the conservation status of the species, state jurisdictional agency staff give the proposed statuses at least the same consideration as the current legal status. If surveys or further information reveal that a threatened and endangered and/or special concern species and resources exist in your project area, contact the appropriate jurisdictional agency/agencies immediately to identify and resolve any impacts.

For a list of species known to occur in the county where your project is located, please see the species lists by county found on the PA Natural Heritage Program (PNHP) home page (www.naturalheritage.state.pa.us). Also note that the PNDI Environmental Review Tool only contains information about species occurrences that have actually been reported to the PNHP.

6. AGENCY CONTACT INFORMATION

PA Department of Conservation and Natural Resources

Bureau of Forestry, Ecological Services Section
400 Market Street, PO Box 8552
Harrisburg, PA 17105-8552
Email: RA-HeritageReview@pa.gov

PA Fish and Boat Commission

Division of Environmental Services
595 E. Rolling Ridge Dr., Bellefonte, PA 16823
Email: RA-FBPACENOTIFY@pa.gov

U.S. Fish and Wildlife Service

Pennsylvania Field Office
Endangered Species Section
110 Radnor Rd; Suite 101
State College, PA 16801
Email: IR1_ESPenn@fws.gov
NO Faxes Please

PA Game Commission

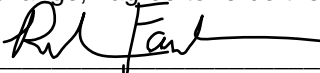
Bureau of Wildlife Management
Division of Environmental Review
2001 Elmerton Avenue, Harrisburg, PA 17110-9797
Email: RA-PGC_PNDI@pa.gov
NO Faxes Please

7. PROJECT CONTACT INFORMATION

Name: Richard Farella
Company/Business Name: Meliora Design
Address: 259 Morgan Street
City, State, Zip: Phoenixville, PA 19460
Phone: (610) 933-0123 Fax: ()
Email: rich@melioradesign.com

8. CERTIFICATION

I certify that ALL of the project information contained in this receipt (including project location, project size/configuration, project type, answers to questions) is true, accurate and complete. In addition, if the project type, location, size or configuration changes, or if the answers to any questions that were asked during this online review change, I agree to re-do the online environmental review.



applicant/project proponent signature

11/4/2022

date



November 10, 2022

IN REPLY REFER TO
SIR# 57021

Meliora Design
Marc Henderson
259 Morgan Street
Philadelphia, Pennsylvania 19460

**RE: Species Impact Review (SIR) – Rare, Candidate, Threatened and Endangered Species
PNDI Search No. 772258_1
Hickory Run State Park Latrine Improvements
Kidder Township: CARBON County**

Dear Marc Henderson:

This responds to your inquiry about a Pennsylvania Natural Diversity Inventory (PNDI) Internet Database search “potential conflict” or a threatened and endangered species impact review. These projects are screened for potential conflicts with rare, candidate, threatened or endangered species under Pennsylvania Fish and Boat Commission jurisdiction (fish, reptiles, amphibians, aquatic invertebrates only) using the Pennsylvania Natural Diversity Inventory (PNDI) database and our own files. These species of special concern are listed under the Endangered Species Act of 1973, the Wild Resource Conservation Act, and the Pennsylvania Fish and Boat Code (Chapter 75), or the Wildlife Code.

An element occurrence of a rare, candidate, threatened, or endangered species under our jurisdiction is known from the vicinity of the proposed project. However, given the nature of the proposed project, the immediate location, or the current status of the nearby element occurrence(s), no adverse impacts are expected to the species of special concern.

This response represents the most up-to-date summary of the PNDI data and our files and is valid for two (2) years from the date of this letter. An absence of recorded species information does not necessarily imply species absence. Our data files and the PNDI system are continuously being updated with species occurrence information. Should project plans change or additional information on listed or proposed species become available, this determination may be reconsidered, and consultation shall be re-initiated.

If you have any questions regarding this review, please contact Jarren Uplinger at 814-359-5239 or jauplinger@pa.gov and refer to the SIR # 57021. Thank you for your cooperation and attention to this important matter of species conservation and habitat protection.

Sincerely,

A handwritten signature in black ink that reads "Christopher A. Urban". The signature is written in a cursive style with a large, prominent initial "C".

Christopher A. Urban, Chief
Natural Diversity Section

CAU//JLU/DN

November 15, 2022

PNDI Number: 772258
Version: Final_1; 11/2/22

Marc Henderson
Meliora Design
259 Morgan St.
Phoenixville, PA 19460
Email: MarcH@MelioraDesign.com (hard copy will not follow)

**Re: UPDATE - Hickory Run State Park Latrine Improvements
Kidder Township, Carbon County, PA**

Dear Marc Henderson,

Thank you for the submission of the Pennsylvania Natural Diversity Inventory (PNDI) Environmental Review Receipt Number **772258 (Final_1)** for review. PA Department of Conservation and Natural Resources screened this project for potential impacts to species and resources under DCNR's responsibility, which includes plants, terrestrial invertebrates, natural communities, and geologic features only. This project was previously reviewed by DCNR under PNDI #715200.

The proposed project will affect State Park Lands within Hickory Run State Park. Further coordination with the Bureau of State Parks may be required. Additional information regarding this coordination is provided under the heading "Projects on State Park Lands."

No Impact Anticipated

PNDI records indicate species or resources under DCNR's jurisdiction are located in the vicinity of the project. However, based on the information you submitted concerning the nature of the project, the immediate location, and our detailed resource information, DCNR has determined that no impact is likely. No further coordination with our agency is needed for this project.

Recommended Best Management Practices:

- Use a conservative approach to project design that minimizes permanent and temporary disturbances to soil and native vegetation. This will conserve habitat and limit opportunities for invasive plants.
- Clean boot treads, tools, construction equipment, and vehicles thoroughly (especially the undercarriage and wheels) before they are brought on site. This will remove invasive plant seeds and invasive earthworms/cocoons that may have been picked up at other worksites.
- Do not use seed mixes that include invasive species. More information about invasive plants in Pennsylvania can be found at the following link: <http://www.dcnr.pa.gov/Conservation/WildPlants/InvasivePlants/Pages/default.aspx>
- Use habitat-appropriate, native seed mixes. For example, use a riparian seed mix when reseeding along a waterway. The Bureau of Forestry Planting & Seeding Guidelines can be found at the following link for recommendations: http://www.docs.dcnr.pa.gov/cs/groups/public/documents/document/dcnr_20031083.pdf

- Consider managing periodically maintained areas and edges for native plant communities and wildlife (e.g., monarch butterfly). In seed mixes, include wildflowers that have overlapping bloom periods and provide forage for pollinators throughout the growing season. Avoid blanket herbicide applications; instead, spot-treat undesirable tall woody vegetation and invasive weeds. Where mowing is necessary, reduce frequency to once every few years during the dormant season (i.e., after first frost in late fall and before bird nesting in early spring), leaving some refugia for overwintering wildlife.
- Monitor for invasive plants before, during, and after project activities and promptly control any identified infestations. Frequent monitoring allows for early detection and rapid response.

Projects on State Park Lands:

A portion of this project takes place within Hickory Run State Park. **This letter applies to PNDI impacts only and does not authorize the initiation of any work on State Park Lands. If you have not already done so, please coordinate with DCNR's Bureau of State Parks.**

This response represents the most up-to-date review of the PNDI data files and is valid for two (2) years only. If project plans change or more information on listed or proposed species becomes available, our determination may be reconsidered. Should the proposed work continue beyond the period covered by this letter and a permit has not been acquired, please resubmit the project to this agency as an "Update" (including an updated PNDI receipt, project narrative, description of project changes and accurate map). As a reminder, this finding applies to potential impacts under DCNR's jurisdiction only. Visit the PNHP website for directions on contacting the Commonwealth's other resource agencies for environmental review.

Should you have any questions or concerns, please contact Stephanie Seymour, Ecological Information Specialist, by phone (717-705-2819) or via email (c-steseymo@pa.gov).

Sincerely,



Greg Podnieszinski, Section Chief
Natural Heritage Section

Subject: FW: [External] RE: Kidder Township, Carbon County; Re: Sewage Facilities Planning for the Hickory Run State Park Latrine Improvements project
Date: Monday, June 6, 2022 at 5:16:36 PM Eastern Daylight Time
From: Marc Henderson <march@melioradesign.com>
To: Todd Woodward <tkw@smparchitects.com>
CC: Megan Strenski <mms@smparchitects.com>

See below from DEP.

Marc Henderson, PE | Meliora Design

P. 610.933.0123 | C. 352.213.7825

From: Bellanca, Amy <abellanca@pa.gov>
Sent: Tuesday, May 24, 2022 3:31 PM
To: Marc Henderson <march@melioradesign.com>; Paul, Adam N <apaul@pa.gov>
Cc: Glavich, Kelsey <kglavich@pa.gov>
Subject: RE: [External] RE: Kidder Township, Carbon County; Re: Sewage Facilities Planning for the Hickory Run State Park Latrine Improvements project

Good afternoon,

The Department of Environmental Protection (DEP) has reviewed the email below regarding the improvements to be performed at Hickory Run State Park.

DEP has concluded that the described improvements represent activities that do not alter the wastewater treatment process, plant capacity, or collection system capacity. Therefore, a Water Quality Management (WQM) permit is not required.

Please keep a copy of this email for your records. Thank you

Amy

Amy Bellanca, P.E. | Environmental Engineer Manager
Department of Environmental Protection | Clean Water Program
Northeast Regional Office
2 Public Square | Wilkes-Barre, PA 18701
Phone: 570.826.2318
www.dep.pa.gov

DEP is now accepting permit and authorization applications, as well as other documents and correspondence, electronically through the OnBase Electronic Forms Upload tool. Please use the link below to view the webpage, get instructions, and submit documents:

<https://www.dep.pa.gov/DataandTools/Pages/Application-Form-Upload.aspx>

PRIVILEGED AND CONFIDENTIAL COMMUNICATION The information transmitted is intended only for the person or

entity to whom it is addressed and may contain confidential and/or privileged material. Any use of this information other than by the intended recipient is prohibited. If you receive this message in error, please send a reply e-mail to the sender and delete the material from any and all computers.

From: Marc Henderson <march@melioradesign.com>
Sent: Monday, May 16, 2022 9:48 AM
To: Bellanca, Amy <abellanca@pa.gov>
Subject: [External] RE: Kidder Township, Carbon County; Re: Sewage Facilities Planning for the Hickory Run State Park Latrine Improvements project

ATTENTION: This email message is from an external sender. Do not open links or attachments from unknown sources. To report suspicious email, forward the message as an attachment to CWOPA_SPAM@pa.gov.

Ms. Bellanca,
I'm still trying to determine if additional permits are necessary for our project to add a lateral to an existing wastewater disposal facility. I will follow up this email with a call today.

Marc Henderson, PE | Meliora Design

P. 610.933.0123 | C. 352.213.7825

From: Marc Henderson
Sent: Wednesday, March 30, 2022 9:14 AM
To: abellanca@pa.gov
Subject: RE: Kidder Township, Carbon County; Re: Sewage Facilities Planning for the Hickory Run State Park Latrine Improvements project

Ms. Bellanca,
I wanted to follow up on this message. Did you have any thoughts on what our reviewer suggested as far as confirming there wouldn't be any outstanding permits required for a sewer connection at Hickory Run. Please let me know.

Marc Henderson, PE | Meliora Design

P. 610.933.0123 | C. 352.213.7825

From: Marc Henderson
Sent: Monday, February 28, 2022 1:10 PM
To: abellanca@pa.gov
Subject: FW: Kidder Township, Carbon County; Re: Sewage Facilities Planning for the Hickory Run State Park Latrine Improvements project

Amy,
You were referenced in a recent email from Todd Stires and I just wanted to check in with you and see what

information you would need to determine if there were other permits required to make connections to existing sanitary laterals for a project we are working on at Hickory Run State Park. See highlighted section below.

Marc Henderson, PE | Meliora Design

P. 610.933.0123 | C. 352.213.7825

From: Stires, Todd <tstires@pa.gov>

Sent: Wednesday, February 23, 2022 6:32 PM

To: robert.fugate18@yahoo.com; KIDDER.PLANNING@PA.METROCAST.NET

Cc: Marc Henderson <march@melioradesign.com>

Subject: Kidder Township, Carbon County; Re: Sewage Facilities Planning for the Hickory Run State Park Latrine Improvements project

Good evening Robert,

As a follow up to our conversation yesterday (2/22); I've been working with Mr. Marc Henderson with Meliora Design on a planning module for latrine improvements and bathhouse replacements at Hickory Run State Park. The core of the conversation has been whether any sewage planning is required for the projects and if so, what type of planning is appropriate considering there are two different types of sewage disposal systems serving the subject areas: a private community sewerage system with treatment facility, and community on-lot sewage systems.

After reviewing previous sewage planning from 2004 (see attached PDF: "HIRU Planning Module_June2004") and our records for the park, it appears planning has been completed and approved to allow the Loop C and the OGTC campground areas to connect to the private community sewerage system, therefore no further planning is required for this portion of the project. The applicant should contact DEP permit chief, Ms. Amy Bellanca to discuss what type of permitting, if any, will be required to modify the existing system to allow the new bathhouses and latrines to connect. Ms. Bellanca can be reached at abellenca@pa.gov or at 507.826.2511

The projects proposed for the Daddy Allen and Shehaqua campground areas also do not appear to meet a requirement for sewage planning. The proposal includes replacement of the exiting bath-houses with newer facilities and does not include plans to increase the number of existing campsites, cabins, RV sites, or other park areas for overnight stays that could lead to an increase in annual/seasonal usage of the bathhouses. Mr. Henderson submitted the attached information (see attached Excel Spreadhseet and PDFs: "Fixture Counts...") illustrating the changes in bathroom amenities to occur as a results of this project. Noting 3-additional showerheads proposed at the Shehaqua campground and 2-additional showerheads at the Daddy Allen; these changes suggest more visitors will be able to use the facilities at one time, rather than the park allowing more visitors to stay overnight.

Unless there are circumstances DEP is not aware of concerning the on-lot system(s) serving the existing bath-houses (such as an existing malfunction or a history of malfunctions); the proposal to replace the bathhouses will not require sewage planning.

Please let me know if you or anyone else has any questions, or concerns, or would like to discuss this matter

in further detail.

Thank you.

V/R -Todd

Todd Stires | Sewage Planning Specialist II
Department of Environmental Protection
2174B Route 611 | Swiftwater, PA 18370
Phone: 570.895.4049
www.dep.pa.gov



Pennsylvania State Historic Preservation Office

PENNSYLVANIA HISTORICAL AND MUSEUM COMMISSION

April 26, 2019

John E. Clifford
Program Services
Park Operations and Maintenance Division
Bureau of State Parks
Rachel Carson State Office Building
PO Box 8551
Harrisburg, PA 17105

RE: ER 2016-0193-025-E; DGS: Multiple Pit Latrine Removal; Hickory Run State Park; Kidder Township, Carbon County

Dear Mr. Clifford,

Thank you for submitting information concerning the above referenced project. The Pennsylvania State Historic Preservation Office (PA SHPO) reviews projects in accordance with state and federal laws. Section 106 of the National Historic Preservation Act of 1966, and the implementing regulations (36 CFR Part 800) of the Advisory Council on Historic Preservation, is the primary federal legislation. The Environmental Rights amendment, Article 1, Section 27 of the Pennsylvania Constitution and the Pennsylvania History Code, 37 Pa. Cons. Stat. Section 500 et seq. (1988) is the primary state legislation. These laws include consideration of the project's potential effects on both historic and archaeological resources.

The latrines are located within the Hickory Run Recreational Demonstration Area (Key No., 201072), which is eligible for listing in the National Register of Historic Places; however, the structures post-date the period of significance for the park, which extends from 1936-1945. Therefore, based on the information received, in our opinion, no historic buildings, districts, structures, objects, and/or archaeological resources will be affected by the proposed project.

Should you encounter archaeological resources during construction and/or be made aware of historic property concerns, please contact our office at (717) 783-8947 for reconsideration of the project.

Sincerely,

Douglas C. McLearn, Chief
Division of Environmental Review



PROJECT REVIEW FORM

Request to Initiate SHPO Consultation on State and Federal Undertakings

SHPO USE ONLY	Reviewers: <u>ED</u> / _____
DATE RECEIVED: <u>6/30/20</u>	DATE DUE: <u>7/29/20</u>
ER NUMBER: <u>2016-0193-025-F</u>	HRSF: <input type="checkbox"/>

REV: 06/2020

SECTION A: PROJECT NAME & LOCATION

Is this a new submittal? YES NO OR This is additional information for ER Number: 2016-0193-025

Project Name Hickory Run State Park Latrine Improvements County Carbon Municipality Kidder Township
 Project Address 3 Family Camp Road City/State/ Zip White Haven PA 18661

SECTION B: CONTACT INFORMATION & MAILING ADDRESS

Name Todd Woodward Phone (215) 985-4410
 Company SMP Architects Fax _____
 Street/PO Box 1600 Walnut Street, 2nd Floor Email tkw@smparchitects.com
 City/State/Zip Philadelphia PA 19103 Email cc: _____

SECTION C: PROJECT DESCRIPTION

This project is located on: Federal property State property Municipal property Private property
 (check all that apply)

List all federal and state agencies and programs providing funds, permits, licenses.	Agency Type	Agency/Program/Permit Name	Project/Permit/Tracking Number (if applicable)	
	State		DGS	114-06 Phase 1
	State		DCNR	

Proposed Work – Attach project description, scope of work, site plans, and/or drawings

Project includes (check all that apply): Construction Demolition Rehabilitation Disposition

Total acres of project area: 1.43 Total acres of earth disturbance: 1.43

Are there any buildings or structures within the project area? Yes No Approximate age of buildings: 1930's or so

Does this project involve properties listed in or eligible for the National Register of Historic Places, or locally designated? Inventory here: <https://gis.penndot.gov/crgis>
 Yes No Unsure Name _____
 Key Number _____

**Please email this form
and pdf attachments to:
RA-PH-PASHPO-ER@pa.gov**

Please be sure to save the Project Review Form so that it remains a digital document and retains its function as a fillable pdf. Do not print the form and scan as a pdf.

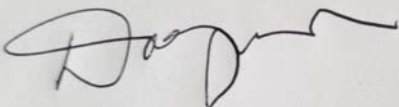
Attachments – Please include the following information with this form

- Map** – 7.5' USGS quad, streetmap, or parcel map showing the project's Area of Potential Effect
- Description/Scope of Work** – Narrative description of the project, including any ground disturbance and previous land use, and any potential to impact historic resources
- Site Plans/Drawings** – Indicate location and age of buildings, any proposed improvements, and past and present land use
- Photographs** – Digital photographs of all buildings and structures on the project site, keyed to a site plan. For projects **directly affecting** buildings older than 50 years old use the Abbreviated HRSF

SHPO RESPONSE (SHPO USE ONLY)

- There are **NO HISTORIC PROPERTIES** in the Area of Potential Effect **SHPO REQUESTS ADDITIONAL INFORMATION** (see attached)
- The project will have **NO EFFECT** on historic properties
- The project will have **NO ADVERSE EFFECTS** on historic properties: Hickory Run RDA Key# 201072

DIVISION CHIEF, ENVIRONMENTAL REVIEW:


DATE: 7/6/20SHPO REVIEWER: ed